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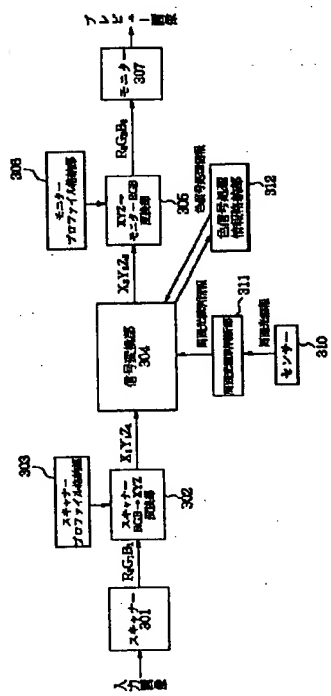
(54)【発明の名称】　画像処理装置及び方法

(57)【要約】

【課題】　周囲光にかかわらず出力画像の色の見えを入力画像に合わせることを目的とする。

【解決手段】　画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理方法であって、任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを、観察光源に依存した画像データに色変換し、該観察光源に依存した画像データを観察時の基準白に基づき色変換し、前記観察時の基準白に依存した画像データを画像出力装置に出力することを特徴とする画像処理方法。



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【特許請求の範囲】

【請求項１】　画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理方法であって、

任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを、観察光源に依存した画像データに色変換し、

該観察光源に依存した画像データを観察時の基準白に基づき色変換し、

前記観察時の基準白に依存した画像データを画像出力装置に出力することを特徴とする画像処理方法。

【請求項２】　前記観察光源に依存した画像データは、前記任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを前記観察光源の特性に基づき色変換することによって得られることを特徴とする請求項１記載の画像処理方法。

【請求項３】　前記観察光源の特性は演色性であることを特徴とする請求項２記載の画像処理方法。

【請求項４】　前記観察光源の特性は分光特性であることを特徴とする請求項２記載の画像処理方法。

【請求項５】　前記観察光源に依存した画像データを観察時の基準白に基づき色変換する処理は前記観察光源の白を前記観察時の基準白に色順応予測を行う処理であることを特徴とする請求項１記載の画像処理方法。

【請求項６】　前記観察時の基準白は前記観察光源の白と前記出力装置の白の各々を示す３刺激値から得られることを特徴とする請求項１記載の画像処理方法。

【請求項７】　画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理方法であって、

任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを周囲光の特性及び観察時の基準白に基づく色順応を加味した画像データに色変換することを特徴とする画像処理方法。

【請求項８】　画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理装置であって、任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを、観察光源に依存した画像データに色変換する第１の色変換手段と、

該観察光源に依存した画像データを観察時の基準白に基づき色変換する第２の色変換手段と、

前記観察時の基準白に依存した画像データを画像出力装置に出力する出力手段とを有することを特徴とする画像処理装置。

【請求項９】　モニター上の表示物と印刷物の色見えを同じにするように画像データに対して色信号変換を行う画像処理装置であって、

周囲光の種類を設定する設定手段と、

周囲光種別に対応する色信号処理情報を予め蓄えておく記憶手段と、

前記設定された周囲光の種別に対応した色信号処理情報に基づき、前記画像データに対して該周囲光の特性及びモニターの白に基づく色順応を加味した色信号変換を行う色信号変換手段とを有することを特徴とする画像処理装置。

【請求項１０】　更に、前記設定手段は前記周囲光の種類を判別するセンサーを有することを特徴とする請求項９記載の画像処理装置。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、周囲光に基づき色補性を行う画像処理装置及び方法に関する。

【０００２】

【従来の技術】近年カラー画像製品が普及し、ＣＧを用いたデザイン作成などの特殊な分野のみでなく一般的なオフィスでもカラー画像を手軽に扱えるようになった。ところで、一般には、モニター上で作成した画像をプリンターで出力した場合両者の色が合わず、モニター上でプリント物の色彩検討を行うことは困難であった。これを解決するための方法として、カラーマネージメントシステムが考案され、注目されている。

【０００３】カラーマネージメントシステムは、共通の色空間を用いることによりデバイスごとの色の違いをなくすものである。これは、同じ色空間において同じ座標で記述される色であれば、それらの色の見えは同じであるという考えのもとに、すべての色を同じ色空間で表現し、その対応する座標を一致させることにより、色の見えの一致を得ようとするものである。現在、一般に用いられている方法の一つとして、色空間としてＣＩＥ－ＸＹＺ色空間を用いて、その内部記述座標値であるＸＹＺ三刺激値を用いて、デバイスごとの違いを補正する方法がある。

【０００４】図１１を用いて画像を観察する環境について説明する。ここではモニター２０３上に印刷物２０１と同じ画像２０２を表示した場合を示しており、画像を観察している時の周囲光２０４は、モニターやプリンター上に設置された周囲光センサー２０６で検知するしくみとなっている。

【０００５】例えば、印刷された画像やＣＲＴ上に表示された画像はいつも決まった周囲光のもとで観察されるのではなく、図１１の周囲光２０４は環境状況によって変化する。さらに、ある周囲光のもとで等色出来たとしても、その周囲光が変化すると今まで一致していた画像が一般に全く異なる画像に見えてしまう。これを回避するために、上記のカラーマネージメントシステムを用い、図１０に示すように、ある環境で観察する際にそれぞれの画像がどのような値（例えばＸＹＺ値）になるかあらかじめセンサー１０９から得た周囲光の情報１０８をもとに予測し、その値を各デバイスごとのプロファイ

ル１０３，１０６を用いて、出来る限り忠実に再現することで色の見えを合わせることが考えられる。

【０００６】この方法を図１０を用いて説明する。まず、入力画像（印刷物）をスキャナー１０１で読み込み、スキャナーＲＧＢ→ＸＹＺ変換部１０２において、あらかじめ具備されているスキャナー特性データが格納されているスキャナープロファイルデータ１０３を用いて、スキャナーから得られるR_1 G_1 B_1 値をデバイスに依存しない色信号X_1 Y_1 Z_1 に変換する。さらに、信号変換部においては、周囲光を感知するセンサー１０９から得られた周囲光情報１０８をもとに、その周囲光のもとで観察した場合の各色ごとの色信号値X_2 Y_2 Z_2 に変換する。そして、モニタープロファイル１０６を用い、ＸＹＺ→モニターＲＧＢ変換部１０５においてモニター入力値であるR_2 G_2 B_2 を算出する。

【０００７】本来上記のような方法を用い、共通色空間上で同じ値となれば同じ色に見えるはずである。しかしながら、モニター上に表示された色と印刷物のように照明することにより得られる色とを比較する時においては、たとえ、それらが同じ値であっても観察者には同じ色に見えないことが知られている。そのため、前述のような環境において、目視で観察して同じ色と知覚できるようにする為には、更なる補正が必要となる。

【０００８】人間は色を観察する時、白を基準としてその白との比較ですべての色を認識していると考えられている。ある周囲光（環境光）のもとにおかれたモニター上の表示物と印刷物を観察する場合を例に考える。

【０００９】このような環境中には、モニターの白・照明光の白・照明光で照らされた画像の白（紙の白）など、多くの白と考えられる（知覚され得る）色がある。その中にいる観察者は、前述の多くの環境中の白に関する知覚を総合して、色を見る時の基準になる白を得る。そして、その白色を基準として色を観察していると考えられる。このため、前述のような環境の中において、基準になる白色を求め、この基準白色を用いてすべての画像の色を変換することで、色に見えを合わせる方法が考えられる。前述の方法の応用例として、例えば、論文（ＳＰＩＥ　Ｐｕｂｌｉｃａｔｉｏｎ　Ｖｏｌ．２１７０ｐｐ１７０．－１８１．）に記述される方法がある。この論文では、蛍光灯下においてモニターの白と蛍光灯の白をもとに基準白を求め、色見えを考慮した色変換処理を行っている。

【００１０】

【発明が解決しようとする課題】前述の、基準になる白色を求め、この基準白色を用いてすべての画像の色を変換することで、色の見えを合わせる方法は、照明光の演色性が高い場合においては、その効果が十分に得られる。しかしながら、一般に照明光の分光分布が異なれば、得られる色刺激値はことなり、更にその色刺激値の変化は、反射物の分光反射率分布に応じて様々に変化する。従って、単純に、ある白色を基準として、すべての画像の色変換を行う方法だけでは、十分に色の見えを合わせることはできない。

【００１１】本発明は上述の点に鑑みてなされたものであり、周囲光（観察光）にかかわらず、出力画像の色の見えを入力画像に合わせることを目的とする。

【００１２】また、演色性等の周囲光の特性まで加味した色変換によって出力画像の色の見えを入力画像に高精度に合わせることを目的とする。

【００１３】

【課題を解決するための手段】上記目的を達成するために以下の構成を有する。

【００１４】本願第１の発明は、画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理方法であって、任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを、観察光源に依存した画像データに色変換し、該観察光源に依存した画像データを観察時の基準白に基づき色変換し、前記観察時の基準白に依存した画像データを画像出力装置に出力することを特徴とする。

【００１５】また本願第２の発明は、画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理方法であって、任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを周囲光の特性及び観察時の基準白に基づく色順応を加味した画像データに色変換することを特徴とする。

【００１６】また、本願第３の発明は、画像出力装置で再現される出力画像の色の見えを入力画像に合わせるべく該入力画像を示す画像データを色変換する画像処理装置であって、任意の標準光源の下に入力装置によって得られた入力画像を示す画像データを、観察光源に依存した画像データに色変換する第１の色変換手段と、該観察光源に依存した画像データを観察時の基準白に基づき色変換する第２の色変換手段と、前記観察時の基準白に依存した画像データを画像出力装置に出力する出力手段とを有することを特徴とする。

【００１７】また、本願第４の発明は、モニター上の表示物と印刷物の色見えを同じにするように画像データに対して色信号変換を行う画像処理装置であって、周囲光の種類を設定する設定手段と、周囲光種別に対応する色信号処理情報を予め蓄えておく記憶手段と、前記設定された周囲光の種別に対応した色信号処理情報に基づき、前記画像データに対して該周囲光の特性及びモニターの白に基づく色順応を加味した色信号変換を行う色信号変換手段とを有することを特徴とする。

【００１８】

【発明の実施の形態】

（実施形態１）図１は実施形態１のデータの流れを示し

た図である。図1は、印刷物をスキャナーで読み取り、印刷物と同じ色に見えるようにモニター上に表示する場合について示した。

【0019】まず入力画像（印刷物）をスキャナーで読み込み、画像信号にする。スキャナー301から得られたR_1 G_1 B_1データを、スキャナー特性が格納されているスキャナープロファイル303の情報をもとに、スキャナーRGB→XYZ変換部302において、デバイスに依存しないX_1 Y_1 Z_1に変換する。

【0020】ここでの変換は、まず、入力ガンマ特性を考慮して、RGB各信号についてルックアップテーブル変換を行う。

【0021】$R_1' = LUT_R\ (R_1)$

$G_1' = LUT_G\ (G_1)$

$B_1' = LUT_B\ (B_1)$

【0022】次に、スキャナーRGBからXYZへの変換を3×3のマトリクス$MTX_{RGB2XYZ}$を用いて行う。

【0023】

【外1】

$$\begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix} = MTX_{RGB2XYZ} \begin{bmatrix} R_1' \\ G_1' \\ B_1' \end{bmatrix}$$

【0024】ここで用いる色空間はXYZ色空間に限るものではなく、デバイスの違いを吸収出来ている色空間であれば、どのような色空間を使用してもよい（例えば、CIELUVやCIELAB等）。

【0025】スキャナープロファイル303にはスキャナーの色特性に関するデータ（上記に示したように色変換マトリックス（RGB→XYZ）やLUTなど）が格納されている。

【0026】さらに、得られたX_1 Y_1 Z_1信号を信号変換部304において、センサー310で得られる周囲光情報をもとに周囲光種別判断部311で得られた周囲光種別に対応した色信号処理情報（詳しくは3×3の2次元マトリクスXYZ12XYZ2）を色信号処理情報格納部312から読みだして信号処理を行い、この観察環境下で印刷物とモニター上の表示物が同じ色見えを与えるように考慮したX_2 Y_2 Z_2に変換する。

【0027】図4には、周囲光としてCIE標準の光（A，C，D65）と補助標準の光Bの分光分布を示す。これらの光源はその色温度が異なる為、周囲光情報として色温度をとり、その種別を判断する。また、図5には、代表的な常用光源D65として用いる蛍光ランプ、標準の光C、キセノンランプの分光分布を示す。これらの光源種別判断の為には色温度は使えない。そこで、新たに波長700nm以上の領域に感度を持つセンサーを準備し、この領域の強度を比較することにより、その種別を判断する。あるいは、蛍光ランプの輝線の位置を含む微小領域に感度を持つセンサーを準備し、この領域の強度を比較することにより、その種別を判断する。前記方法は、対象とする光源の種別分布に応じて適切な方法を用いる。

【0028】上記色信号処理情報は、予め複数種の周囲光に対して、後述する方法により求め、色信号処理情報格納部312に、複数種格納してある。信号変換部304は色信号処理情報格納部312に格納されているマトリクスXYZ12XYZ2に基づき、次式に示される変換を実行する。

【0029】

【外2】

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix} = XYZ12XYZ2 \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

$$XYZ12XYZ2 = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

【0030】前記のマトリックスXYZ12XYZ2は周囲光種別に対応した色信号処理を行う為のマトリクスである。

【0031】モニタープロファイル306にはモニターの色特性に関するデータ（モニターの色温度・発光輝度・蛍光体の色度値・標準色空間からデバイス依存の色信号への色変換情報など）が格納されている。

【0032】次に、信号変換部304で得たX_2 Y_2 Z_2信号を、モニター特性が格納されているモニタープロファイル306の情報をもとに、XYZ→モニターRGB変換部305において、デバイスに依存しないX_2 Y_2 Z_2信号から、モニターデバイスR_2 G_2 B_2信号に変換する。ここでの変換は、まず、XYZからモニターRGBへの変換を3×3のマトリクス$MTX_{XYZ2RGB}$を用いて行う。

【0033】

【外3】

$$\begin{bmatrix} R_2' \\ G_2' \\ B_2' \end{bmatrix} = MTX_{XYZ2RGB} \begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix}$$

【0034】次に、モニター出力ガンマ特性を考慮して、RGB各信号についてルックアップルテーブル変換を行う。

【0035】$R_2 = LUT_R\ (R_2')$

$G_2 = LUT_G\ (G_2')$

$B_2 = LUT_B\ (B_2')$

【００３６】なお、３×３のマトリクス$MTX_{XYZ2RGB}$及びモニター出力ガンマ特性は標準色空間からデバイス依存の色信号への色変換情報としてモニタープロファイル３０６に格納されている。

【００３７】続いて、$R_2\ G_2\ B_2$信号をモニターに送り、モニター画面上にその信号に応じた画像を表示する。

【００３８】これらの手順により、この観察環境下で、印刷物と同じ色に見えるように、印刷物画像をモニター上に表示することができる。

【００３９】次に、ある照明光（環境光）下で画像を観察した場合を例にとり、その照明光に対応した色信号処理情報としての色信号変換マトリクスＸＹＺ１２ＸＹＺ２の作成方法をのべる。ＸＹＺ１２ＸＹＺ２は次のマトリクス演算により得られる。

【００４０】

【外４】

$$XYZ12XYZ2 = M^{-1} \cdot D \cdot M \cdot CR$$

$$D = \begin{bmatrix} \frac{R_w}{R_{w1}} & 0 & 0 \\ 0 & \frac{G_w}{G_{w1}} & 0 \\ 0 & 0 & \frac{B_w}{B_{w1}} \end{bmatrix}$$

$$\begin{bmatrix} R_{w1} \\ G_{w1} \\ B_{w1} \end{bmatrix} = M \begin{bmatrix} X_{w1} \\ Y_{w1} \\ Z_{w1} \end{bmatrix}$$

$$\begin{bmatrix} R_w \\ G_w \\ B_w \end{bmatrix} = M \begin{bmatrix} X_w \\ Y_w \\ Z_w \end{bmatrix}$$

【００４１】前記のマトリクスＭはＣＩＥＸＹＺ表色系で表された三刺激値ＸＹＺを人間の目の受光器（錐状体）レベルでの応答量ＲＧＢに変換するマトリクスである（色彩工学の基礎・朝倉書店：ｐ．２１６等を参照のこと）。$X_{w1}Y_{w1}Z_{w1}$は周囲光（観察環境白）の三刺激値である。また、$X_w\ Y_w\ Z_w$は、基準白の三刺激値であり、上記周囲光（観察環境白）の三刺激値$X_{w1}Y_{w1}Z_{w1}$及びモニター白色の三刺激値$X_{w2}Y_{w2}Z_{w2}$を用いて、次式により求める。

【００４２】$X_w = (1-s) \cdot X_{w1} + s \cdot X_{w2}$

$Y_w = (1-s) \cdot Y_{w1} + s \cdot Y_{w2}$

$Z_w = (1-s) \cdot Z_{w1} + s \cdot Z_{w2}$

ここで、$X_w\ Y_w\ Z_w$はモニター３０７上に表示された画像を観察する際の白の三刺激値である。モニター画面に表示される画像を観察する場合、人間はモニター白色のみに完全順応しているのでなく、モニタ白色と周囲光の両方にある割合で順応している。よって、モニターの色色に順応する場合、即ち、モニターの白色が観察環境白対して基準白に与える影響を示すパラメータ（順応比率）をｓとすると、基準白色の三刺激値$X_w\ Y_w\ Z_w$を上述の式で求めることができる。

【００４３】順応比率ｓは周囲光の色温度及び画像の背景色（モニターの背景色）によって変化する。例えば、背景色が黒から白までグレー・スケール・レベルで変化させた場合、背景色が黒に近づくほど周囲光に順応する割合が大きくなる。周囲光の三刺激値及びモニター白色の三刺激値は、色彩輝度計等の測色装置を用いて求めた。

【００４４】マトリクスＣＲは、標準的な色空間（標準的な色空間ではＤ６５やＤ５０といった標準光源がベースとして用いられる。）を用いて記述された色彩信号（$X_1Y_1\ Z_1$）を観察時に用いられる光源（周囲光）の特性（分光特性、演色性等）を考慮した色彩信号（$X_1'\ Y_1'\ Z_1'$）に変換するマトリクスである。ここではマトリクスＣＲとして３×３のマトリクスを用いた。マトリクスＣＲを用いて、光源特性を考慮した色彩信号（$X_1'\ Y_1'\ Z_1'$）は次式により標準色空間で記述された色彩信号（$X_1\ Y_1\ Z_1$）から得られる。

【００４５】

【外５】

$$\begin{bmatrix} X_1' \\ Y_1' \\ Z_1' \end{bmatrix} = CR \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

【００４６】マトリクスＣＲの実際の係数は、図２に示す様な７７色の色パッチからなるテストチャートを用いて、ある照明光下での三刺激値を計測により求めた計測値と、標準色空間を用いて記述した色彩信号値（三刺激値）をデータとして用いて、減衰最小２乗法を用いて最適化を行うことにより求めた。あるいは、７７色の色パッチの分光反射率を分光光度計により求めて、これと分光輝度計により計測した照明光の分光強度分布より、その照明光下での三刺激値を求め、上記と同じように最適化手法を用いて、マトリクスＣＲの実際の係数を得た。上記、計測手段は場合に応じて、最適な手段を用いた。

【００４７】マトリクスＸＹＺ１２ＸＹＺ２は図９に示されるように概念的にはマトリクスＣＲとマトリクス$M^{-1} \cdot D \cdot M$の２つの要素によって構成されている。

【００４８】マトリクスＣＲは上述した様にスキャナーが有する標準光源に依存した標準的な色空間を用いて記述された色彩信号（$X_1\ Y_1\ Z_1$）を周囲光（$X_{w1}Y_{w1}Z_{w1}$）の特性を考慮した色彩信号（$X_1'\ Y_1'\ Z$

$_1$′）に変換するためのマトリクスである。即ち、マトリクスCRは演色性等の光源の特性に基づき標準光源に依存したX_1 Y_1 Z_1を周囲光に依存したX_1′ Y_1′ Z_1′に変換する。

【0049】そして、他の要素であるマトリクスM^{-1}・D・Mは色順応予測理論であるＶｏｎ　Ｋｒｅｉｓの理論に基づき周囲光に依存したX_1′ Y_1′ Z_1′を基準白に依存したX_2 Y_2 Z_2に変換する。

【0050】このように、まず、周囲光の特性に基づき変換し、次に、観察環境白及び基準白とに基づき色順応予測することにより、周囲光の特性（分光特性、演色特性等）及び人間の色順応（モニターの画像における基準白がモニター白色及び周囲光白の両方の影響を受けること）を加味した良好な信号変換を行うことができる。

【0051】したがって、入力画像とモニター３０７上に表示された画像の色見えを一致させることができる。

【0052】（実施形態２）実施形態２として、図３に図示するようにシステムの一部として色信号処理情報演算部３１４を設けた構成による実施形態について説明する。本実施形態では、色信号処理情報が予め準備されているのではなく、センサー３１０で得られる周囲光情報に応じて、演算部３１４で、色信号処理情報を得る。色信号処理情報を得る演算は、実施形態１の色信号変換マトリクスを求める方法として説明した次のマトリクス演算が実行される。

【0053】

ＸＹＺ１２ＸＹＺ２$=M^{-1}\cdot D\cdot M\cdot CR$

【0054】

【外６】

$$D=\begin{bmatrix}\frac{R_w}{R_{w1}} & 0 & 0\\ 0 & \frac{G_w}{G_{w1}} & 0\\ 0 & 0 & \frac{B_w}{B_{w1}}\end{bmatrix}$$

$$\begin{bmatrix}R_{w1}\\ G_{w1}\\ B_{w1}\end{bmatrix}=M\begin{bmatrix}X_{w1}\\ Y_{w1}\\ Z_{w1}\end{bmatrix}$$

$$\begin{bmatrix}R_w\\ G_w\\ B_w\end{bmatrix}=M\begin{bmatrix}X_w\\ Y_w\\ Z_w\end{bmatrix}$$

【0055】前記のマトリクスMはＣＩＥＸＹＺ表色系で表された三刺激値ＸＹＺを人間の目の受光器（錐状体）レベルでの応答量ＲＧＢに変換するマトリクスである。$X_{w1}Y_{w1}Z_{w1}$は周囲光（観察環境白）の三刺激値である。また、X_w Y_w Z_wは、基準白の三刺激値であり、上記周囲光（観察環境白）の三刺激値及びモニター白色の三刺激値$X_{w2}Y_{w2}Z_{w2}$を用いて、次式により求める。

【0056】$X_w=(1-s)\cdot X_{w1}+s\cdot X_{w2}$

$Y_w=(1-s)\cdot Y_{w1}+s\cdot Y_{w2}$

$Z_w=(1-s)\cdot Z_{w1}+s\cdot Z_{w2}$

ｓはモニター白色、観察環境白が基準白色に与える影響を示すパラメータである。周囲光の三刺激値及びモニター白色の三刺激値は、色彩輝度計等の測色装置を用いて求めて、値をシステムに入力することも可能であるが、ここでは、周囲光の三刺激値はセンサー３１０から得られる値を用いた。その為、センサー３１０が周囲光情報を三刺激値$X_{w0}Y_{w0}Z_{w0}$として出力する装置構成とした。三刺激値$X_{w0}Y_{w0}Z_{w0}$はそのときの周囲光の色（白）を表す。本装置は、図６に示す異なる分光感度特性を持つ三つの光センサーを用いた回路構成とした。三つの光センサーからはそれぞれの分光感度特性に応じて出力$R_{s0}G_{s0}B_{s0}$が得られる。三刺激値ＸＹＺを得るための分光感度特性は図７に示すものであり、本装置で用いたセンサーの分光感度特性（図６）と異なる。従って、センサー出力$R_{s0}G_{s0}B_{s0}$から三刺激値$X_{w0}Y_{w0}Z_{w0}$への変換が必要である。本実施形態ではその変換を３×３のマトリクスMTX_{senser}を用いて次式により行った。

【0057】

【外７】

$$\begin{bmatrix}X_{w0}\\ Y_{w0}\\ Z_{w0}\end{bmatrix}=MTX_{senser}\begin{bmatrix}R_{s0}\\ G_{s0}\\ B_{s0}\end{bmatrix}$$

【0058】上記のマトリクス演算は装置内に構成したデジタル信号処理回路で実行した。

【0059】マトリクスＣＲは、標準的な色空間（標準的な色空間ではＤ６５やＤ５０といった標準光源がベースとして用いられる。）を用いて記述された色彩信号（ＸＹＺ）を観察時に用いられる光源（周囲光）の特性（分光特性、演色性等）を考慮した色彩信号（Ｘ′Ｙ′Ｚ′）に変換するマトリクスである。ここではマトリクスＣＲとして３×３のマトリクスを用いた。マトリクスＣＲを用いて、光源特性を考慮した色彩信号（Ｘ′Ｙ′Ｚ′）は次式により標準色空間で記述された色彩信号（ＸＹＺ）から得られる。

【0060】

【外８】

$$\begin{bmatrix}X'\\ Y'\\ Z'\end{bmatrix}=CR\begin{bmatrix}X\\ Y\\ Z\end{bmatrix}$$

【0061】マトリクスＣＲの実際の係数は、図２に示す様な７７色の色パッチからなるテストチャートを用い

て、ある照明光下での三刺激値を計測により求めた計測値と、標準色空間を用いて記述した色彩信号値（三刺激値）をデータとして用いて、減衰最小２乗法を用いて最適化を行うことにより求めた。あるいは、７７色の色パッチの分光反射率を分光光度計により求めて、これと分光輝度計により計測した照明光の分光強度分布より、その照明光下での三刺激値を求め、上記と同じように最適化手法を用いて、マトリクスＣＲの実際の係数を得た。上記、計測手段は場合に応じて、最適な手段を用いた。

【００６２】上記の様にして作成した、マトリクスＣＲは周囲光特性補正情報として、周囲光特性補正情報格納部３１３に記憶保存した。

【００６３】演算の際に用いられるマトリクスＣＲは、センサー３１０から得られる周囲光情報をもとに、周囲光種別判断部３１１で、実施形態１で説明した様にして種別判断を行って、この周囲光種別情報を用いて、対応する周囲光特性補正情報を周囲光特性補正情報格納部３１３から選択して用いる。

【００６４】他の動作は、実施形態１で説明した動作がほぼ実行される。

【００６５】本実施形態では、信号変換部３０４で実際に用いる色信号処理情報を色信号処理情報演算部３１４で演算により求める構成としたので、モニターに依存しない様に、あるいは周囲光の色度や輝度に依存しない様に、周囲光特性補正情報として色信号処理情報を予め準備すれば良くなるので、実施形態１と較べ、予め準備記憶して置く色信号処理情報の、種別数をすくなくすることができる。

【００６６】（実施形態３）実施形態３として、図８に図示するようにシステムの一部として周囲光種別指示部３１５を設けた構成による実施形態について説明する。

【００６７】本実施形態の基本動作は、実施形態１で説明した動作とほぼ同じである。実施形態１では、センサー３１０で得られる周囲光情報を用いて、システム内の周囲光種別判断部３１１で、システムが自動的に周囲光種別を得る構成としたが、本実施形態では、周囲光種別指示部３１５を設けたことにより、周囲光種別を直接指示する構成とした。これにより、周囲光種別を誤認することが避けられる。また、現在の環境下以外での周囲光での観察され得る画像をモニター上に表示することができる。周囲光種別の指示は、画面上に一覧表示された周囲光番号を、マウスやキーボードで選択することにより行った。このとき、指示判断の情報として、色温度や分光特性を画面上に表示することも可能とした。

【００６８】これまでに示した各実施形態に見られるように、観察環境中に知覚され得る色が多数ある時にそのような白を総合して基準白を求め、この基準白を用いて色信号処理を行って、モニター上の表示物と印刷物の色見えを同じにする際に、周囲光の特性（分光特性、演色性等）を十分に考慮して、色彩信号を変換する。

【００６９】詳しくは、照明光（環境光）についての情報（色度値、色温度あるいは分光強度（照度）等）から、その照明光（環境光）にて知覚される白（その照明光下で紙の白）についての情報（色度値、ＸＹＺ三刺激値等）を求めるとともに、他の色を変換する情報（例えば、２次元マトリクス等）を得、これらの情報を用いて色信号変換を行う。

【００７０】上述の各実施例によれば様々な周囲光光源に対応して精度良く色彩信号を変換することができ、モニター上の表示物と印刷物に関して、十分な精度で同じ見えを得ることが可能となる。

【００７１】なお、上述の各実施形態ではＶｏｎ　Ｋｒｅｉｓの理論を色順応予測理論として用いたが他の色順応予測理論を適用しても構わない。

【００７２】また、本発明は様々なハード構成とそれに応じたシーケンス処理に適用できる。これらのシーケンス処理は例えば、論理化されあるいはソフトウエア化され、または、前述の本発明の主旨を逸脱しない範囲においてアルゴリズム化され、このアルゴリズムに従ってハードウエアや装置として応用可能である。

【００７３】また、本発明は、プリントされる画像をモニターにあらかじめ表示する機能を具備した、プレビューワー機能付きの複写機やプリンターなどに用いることが可能である。さらに、本発明をカラーマネージメントシステムの処理方法として様々な入出力機器の色信号変換の際に使用する事など、あらゆる場合の色信号変換を行う画像処理装置にも用いる事が出来る。

【００７４】

【発明の効果】以上説明した様に、本発明によれば、周囲光（観察光）にかかわらず出力画像の色の見えを入力画像に合わせることができる。

【００７５】また、演色性等の周囲光の特性まで加味した色変換によって出力画像の色の見えを入力画像に高精度に合わせることができる。

【図面の簡単な説明】

【図１】実施形態１について示した図である。

【図２】実施形態１に述べた、マトリクスＣＲの係数を得る為に用いた、７７色の色パッチからなるテストチャートを示した図である。

【図３】実施形態２について示した図である。

【図４】周囲光の例としてのＣＩＥ標準の光（Ａ，Ｃ，Ｄ６５）と補助標準の光Ｂの分光分布を示した図である。

【図５】周囲光の例として、代表的な常用光源Ｄ６５として用いる蛍光ランプ、標準の光Ｃ、キセノンランプの分光分布を示した図である。

【図６】実施形態で用いたセンサーの分光感度特性を示す図である。

【図７】三刺激値ＸＹＺを求める為の分光感度特性を示す図である。

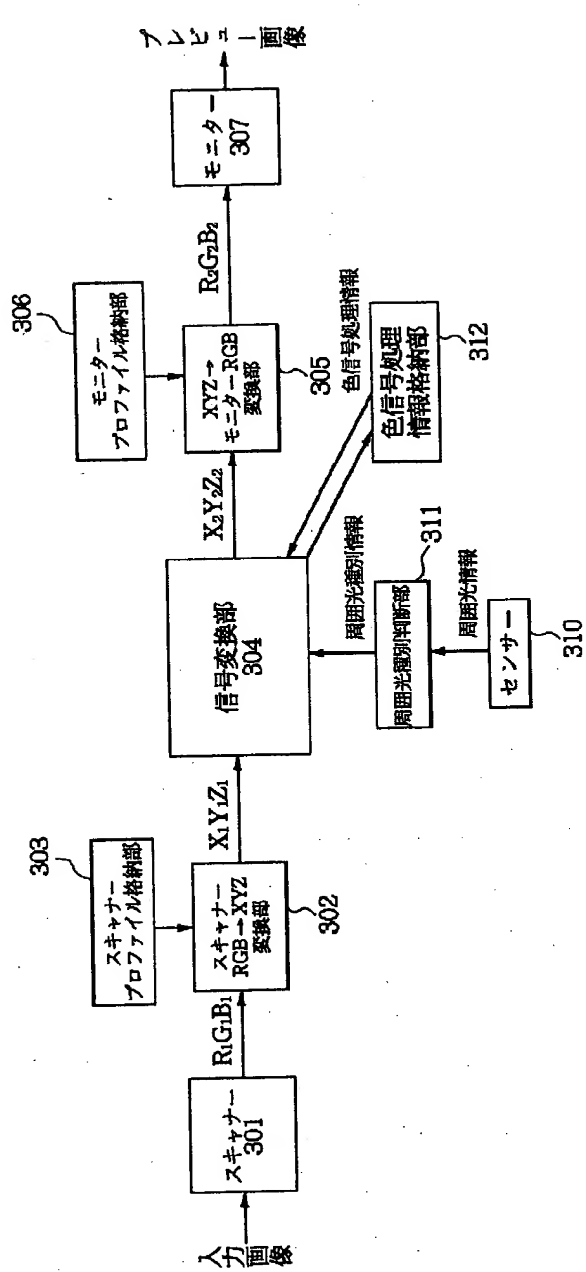
【図８】実施形態３について示した図である。

【図９】信号変換部３０４でのデータの流れを示す図である。

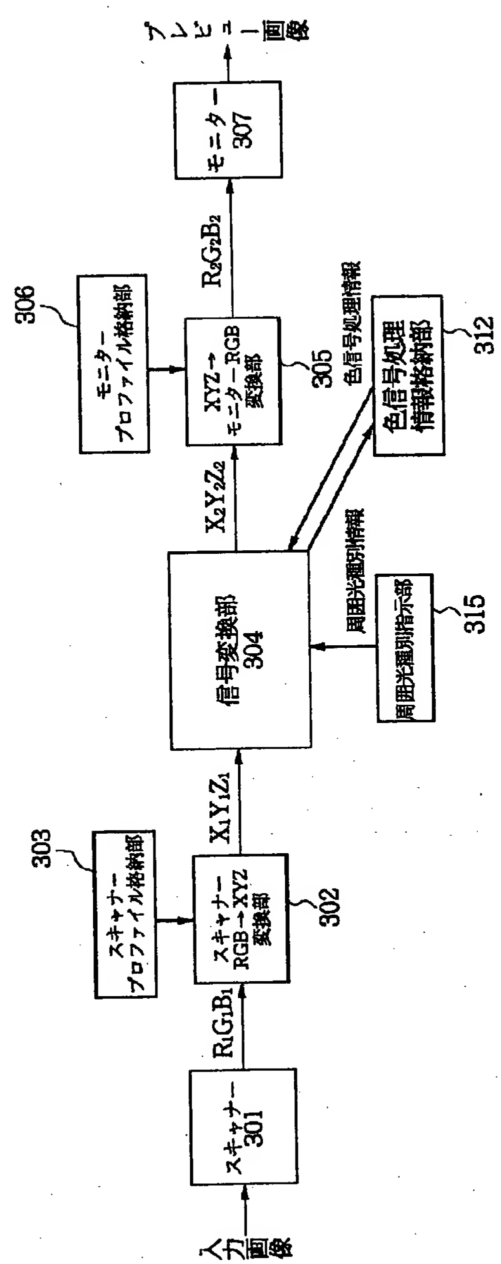
【図１０】従来例について示した図である。

【図１１】画像の観察環境を示した図である。

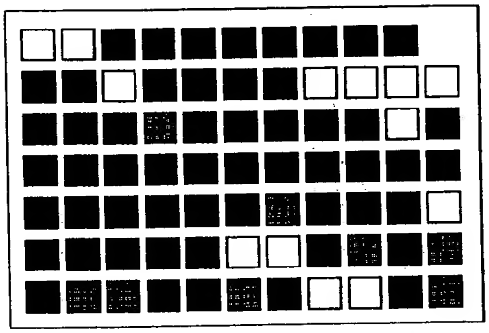
【図１】



【図８】

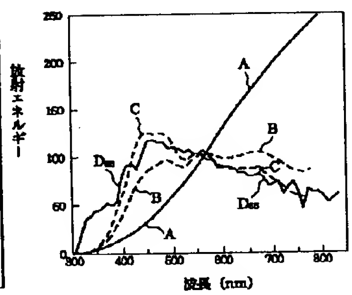


【図２】



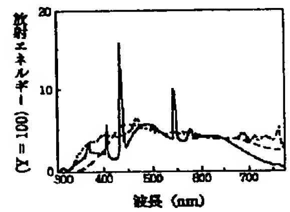
【図４】

標準の光A、D65、C及び補助標準の光Bの分光分布



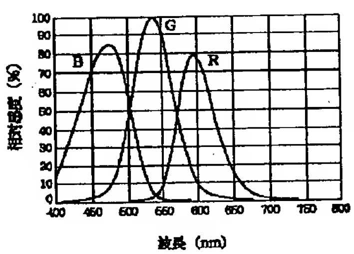
【図５】

代表的な常用光源D65として用いる蛍光ランプ（実線）、標準の光C（破線）、キセノンランプ（点線）の分光分布



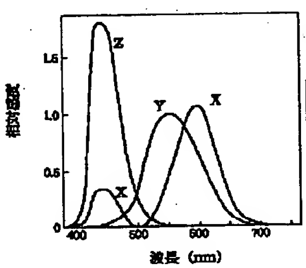
【図６】

センサ分光感度特性

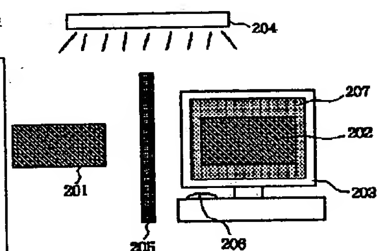


【図７】

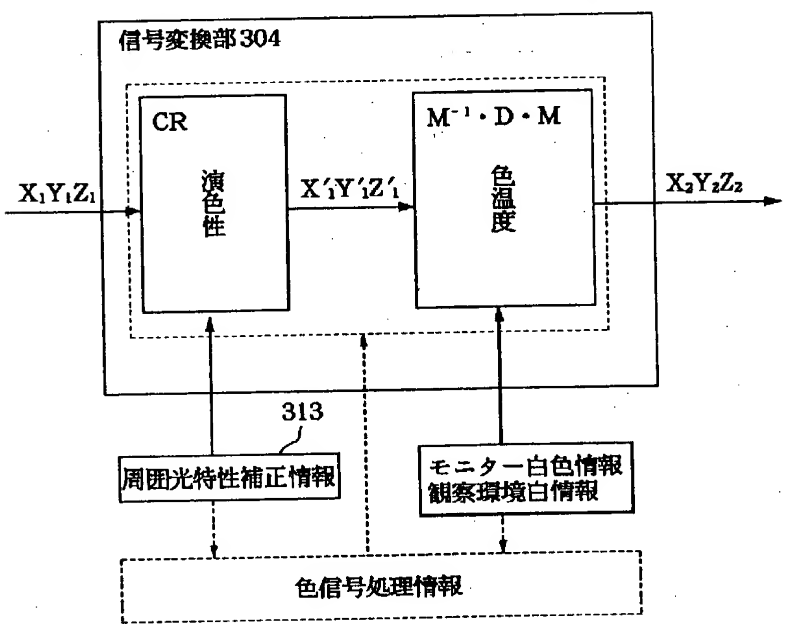
三刺激値を得るための分光感度特性



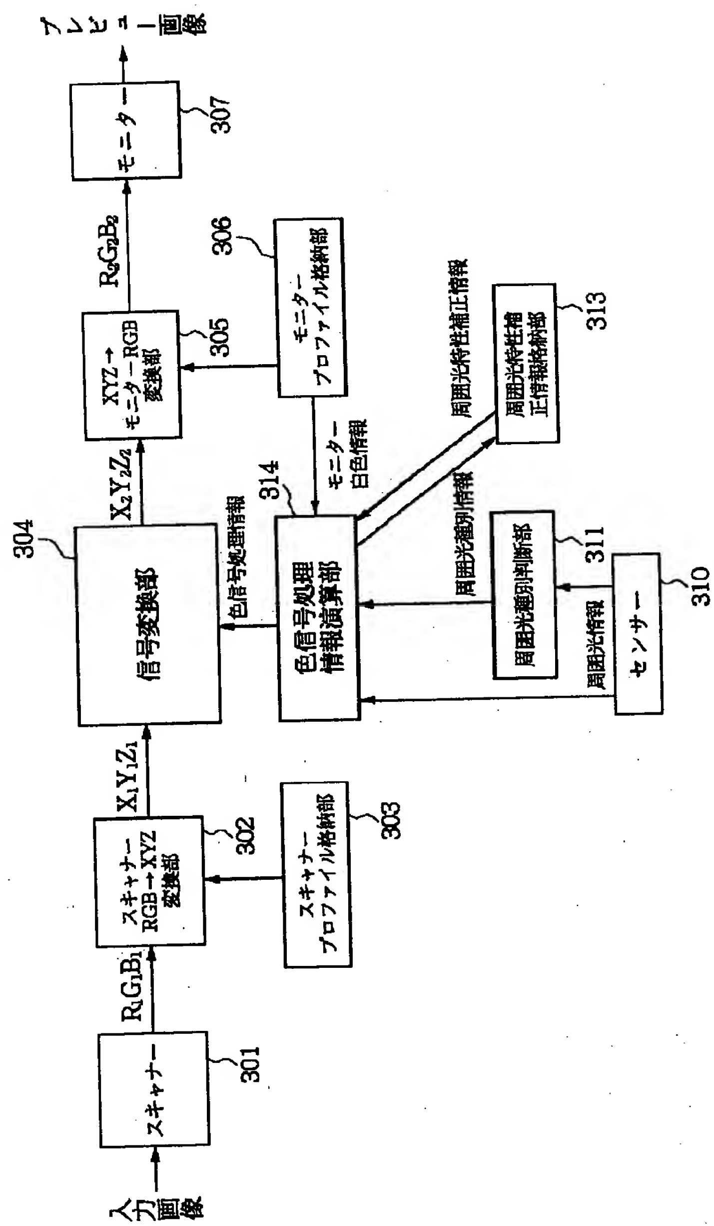
【図１１】



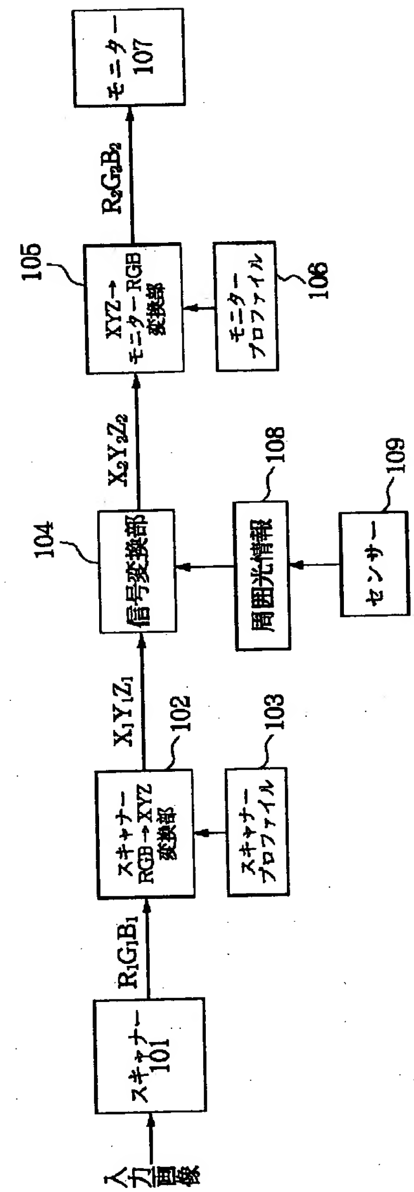
【図９】



【図３】


入力画像
スキャナー
301
$R_1G_1B_1$
スキャナー RGB→XYZ 変換部
302
スキャナー プロファイル格納部
303
$X_1Y_1Z_1$
信号変換部
304
色信号処理情報
色信号処理 情報演算部
314
$X_2Y_2Z_2$
XYZ→ モニターRGB 変換部
305
モニター プロファイル格納部
306
モニター 白色情報
$R_2G_2B_2$
モニター
307
プレビュー画像
周囲光特性補正情報
周囲光特性補正情報格納部
313
周囲光種別情報
周囲光種別判断部
311
周囲光情報
センサー
310

【図１０】


入力画像
スキャナー 101
$R_1G_1B_1$
スキャナー RGB→XYZ 変換部
102
スキャナー プロファイル
103
$X_1Y_1Z_1$
信号変換部
104
周囲光情報
108
センサー
109
$X_2Y_2Z_2$
XYZ→ モニターRGB 変換部
105
モニター プロファイル
106
$R_2G_2B_2$
モニター 107

CLAIMS

[Claim(s)]
[Claim 1] It is the image-processing approach which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The image data which shows the input image obtained with the input device under the standard light source of arbitration The image-processing approach which carries out color conversion at the image data depending on the observation light source, carries out color conversion of the image data depending on this observation light source based on the criteria white at the time of observation, and is characterized by outputting the image data depending on the criteria white at the time of said observation to an image output unit.
[Claim 2] The image data depending on said observation light source is the image-processing approach according to claim 1 characterized by being obtained by carrying out color conversion of the image data which shows the input image obtained with the input device under the standard light source of said arbitration based on the property of said observation light source.
[Claim 3] The property of said observation light source is the image-processing approach according to claim 2 characterized by being color rendering properties.
[Claim 4] The property of said observation light source is the image-processing approach according to claim 2 characterized by being the spectral characteristic.
[Claim 5] The processing which carries out color conversion of the image data depending on said observation light source based on the criteria white at the time of observation is the image-processing approach according to claim 1 characterized by being the processing which performs chromatic adaptation prediction for the white of said observation light source in the criteria white at the time of said observation.
[Claim 6] The criteria white at the time of said observation is the image-processing approach according to claim 1 characterized by being obtained from the tristimulus value which shows each of the white of said observation light source, and the white of said output unit.
[Claim 7] The image-processing approach characterized by to carry out color conversion at the image data which considered the chromatic adaptation based on the property of an ambient light, and the criteria white at the time of observation for the image data which shows the input image which is the image-processing approach which carries out color conversion of the image data which shows this input image in order with an input image the vanity of the color of the output image reproduced with an image output unit, and was obtained with the input device under the standard light source of arbitration.
[Claim 8] It is the image processing system which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The 1st color conversion means which carries out color conversion of the image data which shows the input image obtained with the input device under the standard light source of arbitration at the image data depending on the observation light source, The image processing system characterized by having the 2nd color conversion means which carries out color conversion of the image data depending on this observation light source based on the criteria white at the time of observation, and an output

means to output the image data depending on the criteria white at the time of said observation to an image output unit.

[Claim 9] A setting means to be the image processing system which performs chrominance-signal conversion to image data as color vanity of the display object and printed matter on a monitor is made the same, and to set up the class of ambient light, A storage means to store beforehand the chrominance-signal processing information corresponding to ambient-light classification, The image processing system characterized by having a chrominance-signal conversion means to perform chrominance-signal conversion which considered the chromatic adaptation based on the property of this ambient light, and a monitor's white to said image data, based on the chrominance-signal processing information corresponding to the classification of said set-up ambient light.

[Claim 10] Furthermore, said setting means is an image processing system according to claim 9 characterized by having the sensor which distinguishes the class of said ambient light.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the image processing system and approach of performing ****** based on an ambient light.
[0002]
[Description of the Prior Art] A color picture product spreads in recent years, and a color picture can be easily treated now also not only in special fields, such as design creation using CG, but in general office. By the way, it was difficult for both color not to suit, when the image created on the monitor is generally outputted by the printer, but to perform color examination of a print object on a monitor. As an approach for solving this, a color management system is devised and attracts attention.
[0003] A color management system loses the difference in the color for every device by using a common color space. If this is a color described with the same coordinate in the same color space, it tends to obtain coincidence of the vanity of a color by expressing all colors on the basis of the idea that the vanity of those colors is the same in the same color space, and making the corresponding coordinate in agreement with it. There is the approach of amending the difference for every device as one of the approaches generally used now using the XYZ tristimulus values which are the internal description coordinate value, using a CIE-XYZ color space as a color space.
[0004] The environment where an image is observed using drawing 11 is explained. The case where printed matter 201 and the same image 202 are displayed on a monitor 203 here is shown, and the ambient light 204 when observing the image serves as structure detected by the ambient-light sensor 206 installed on the monitor or the printer.
[0005] For example, neither the printed image nor the image displayed on CRT is observed under the always regular ambient light, but the ambient light 204 of drawing 11 changes with environmental situations. Furthermore, it is the basis of a certain ambient light, and even if it can carry out color matching, if the ambient light changes, it will be visible [the image which was in agreement until now] to an image which is generally completely different. In order to avoid this, as the above-mentioned color management system is used and it is shown in drawing 10 , in case it observes in a certain environment, each image becomes what kind of value (for example, XYZ value), or it predicts based on the information 108 on the ambient light beforehand obtained from the sensor 109, and it is possible to double the vanity of a color reproducing the value using the profile 103,106 for every device as faithfully as possible.
[0006] This approach is explained using drawing 10 . First, R1 G1 B1 which reads an input image (printed matter) with a scanner 101, and is obtained from a scanner in the scanner RGB->XYZ transducer 102 using the scanner profile data 103 with which the scanner property data provided beforehand are stored Chrominance-signal X1 Y1 Z1 which does not depend for a value on a device It changes. Furthermore, chrominance-signal value X2 Y2 Z2 for every color at the time of observing under the ambient light based on the ambient-light information 108 acquired from the sensor 109 which senses an ambient light in the signal transformation section It changes. And R2 G2 B-2 which is [in / using the monitor profile 106 / the XYZ-> monitor RGB

transducer 105] a monitor input value It computes.
[0007] Using the approaches above originally, if it becomes the same value on a common color space, it must be visible to the same color. However, when comparing the color obtained by illuminating like the color displayed on the monitor, and printed matter, even if they are the same values, it is known by the observer that it is not visible to the same color. Therefore, in the above environments, in order to observe visually and to enable it to perceive the same color, the further amendment is needed.
[0008] Human being is considered to recognize all colors by the comparison with the white on the basis of white when observing a color. The case where the display object and printed matter on the monitor which set on the basis of a certain ambient light (ambient light) are observed is considered for an example.
[0009] The color considered to be much white, such as white (white of paper) of the image illuminated by the white and the illumination light of the white and illumination light of a monitor, (perceived) is in such an environment. The observer who is in it synthesizes the consciousness about the white in the environment of above-mentioned many, and gets the white which becomes the criteria when seeing a color. And it is thought that the color is observed on the basis of the white. For this reason, it asks for the white which becomes criteria into the above environments, and how to double vanity with a color can be considered by changing the color of all images using this reference white. As an application of the above-mentioned approach, there is an approach described by the paper (SPIE Publication Vol.2170pp170.-181.). In this paper, the bottom of a fluorescent lamp is asked for criteria white based on a monitor's white and the white of a fluorescent lamp, and color transform processing in consideration of color vanity is performed.
[0010]
[Problem(s) to be Solved by the Invention] By asking for the white which becomes the above-mentioned criteria, and changing the color of all images using this reference white, when the approach of doubling the vanity of a color has the high color rendering properties of the illumination light, that effectiveness is fully acquired. However, if the spectral distributions of the illumination light generally differ, in the colour stimulus specification obtained, change of the colour stimulus specification will change variously in things according to spectral-reflectance distribution of a reflective object further. Therefore, vanity of a color cannot fully be simply doubled only by the approach of performing color conversion of all images on the basis of a certain white.
[0011] This invention is made in view of an above-mentioned point, and it aims at doubling the vanity of the color of an output image with an input image irrespective of an ambient light (observation light).
[0012] Moreover, it aims at doubling the vanity of the color of an output image with an input image with high precision by color conversion considered to the property of ambient lights, such as color rendering properties.
[0013]
[Means for Solving the Problem] It has the following configurations, in order to attain the above-mentioned purpose.
[0014] This application the 1st invention is the image-processing approach which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The image data which shows the input image obtained with the input device under the standard light source of arbitration Color conversion is carried out at the image data depending on the observation light source, color conversion of the image data depending on this observation light source is carried out based on the criteria white at the time of observation, and it is characterized by outputting the image data depending on the criteria white at the time of said observation to an image output unit.
[0015] Moreover, it is the image-processing approach which carries out color conversion of the image data which shows this input image so that this application the 2nd invention doubles with an input image the vanity of the color of the output image reproduced with an image output unit,

and it is characterized by to carry out color conversion at the image data which considered the chromatic adaptation based on the property of an ambient light, and the criteria white at the time of observation for the image data which shows the input image obtained with the input device under the standard light source of arbitration.

[0016] Moreover, this application the 3rd invention is an image processing system which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The 1st color conversion means which carries out color conversion of the image data which shows the input image obtained with the input device under the standard light source of arbitration at the image data depending on the observation light source, It is characterized by having the 2nd color conversion means which carries out color conversion of the image data depending on this observation light source based on the criteria white at the time of observation, and an output means to output the image data depending on the criteria white at the time of said observation to an image output unit.

[0017] Moreover, a setting means for this application the 4th invention to be an image processing system which performs chrominance-signal conversion to image data as color vanity of the display object and printed matter on a monitor is made the same, and to set up the class of ambient light, A storage means to store beforehand the chrominance-signal processing information corresponding to ambient-light classification, It is characterized by having a chrominance-signal conversion means to perform chrominance-signal conversion which considered the chromatic adaptation based on the property of this ambient light, and a monitor's white to said image data, based on the chrominance-signal processing information corresponding to the classification of said set-up ambient light.

[0018]

[Embodiment of the Invention]

(Operation gestalt 1) Drawing 1 is drawing having shown the data flow of the operation gestalt 1. Drawing 1 read printed matter with the scanner, and showed the case where it was displayed on a monitor that it is visible to the same color as printed matter.

[0019] An input image (printed matter) is first read with a scanner, and it is made a picture signal. R1 G1 B1 obtained from the scanner 301 X1 Y1 Z1 which is not dependent on a device in the scanner RGB->XYZ transducer 302 based on the information on the scanner profile 303 that data are stored in the scanner property It changes.

[0020] Conversion here performs look-up table conversion about RGB each signal in consideration of an input gamma property first.

[0021] R1 '=LUTR (R1)

G1 '=LUTG (G1)

B1 '=LUTB (B1)

[0022] Next, it is matrix MTXRGB2XYZ of 3x3 about the conversion to XYZ from Scanner RGB. It carries out by using.

[0023]

[External Character 1]

$$\begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix} = MTX_{RGB2XYZ} \begin{bmatrix} R_1' \\ G_1' \\ B_1' \end{bmatrix}$$

[0024] The color space used here is not restricted to a XYZ color space, and as long as it is the color space which can be absorbing the difference in a device, what kind of color space may be used (for example, CIELUV, CIELAB, etc.).

[0025] The data (as shown above, they are a color transformation matrix (RGB->XYZ), LUT, etc.) about the color property of a scanner are stored in the scanner profile 303.

[0026] Furthermore, X1 Y1 Z1 obtained A signal is set in the signal transformation section 304. Read the chrominance-signal processing information (in detail the two-dimensional matrix XYZ12

of 3x3 XYZ2) corresponding to the ambient-light classification obtained in the ambient-light classification decision section 311 based on the ambient-light information acquired by the sensor 310 from the chrominance-signal processing information storing section 312, and signal processing is performed. X2 Y2 Z2 considered as printed matter and the display object on a monitor giving the same color vanity under this observation environment It changes.

[0027] The spectral distribution of a CIE standard illuminant (A, C, D65) and an auxiliary standard illuminant B are shown in drawing 4 as an ambient light. Since the color temperatures differ, these light sources take a color temperature as ambient-light information, and judge the classification. Moreover, the spectral distribution of the fluorescent lamp used for drawing 5 as the typical common light source D65, standard illuminant C, and a xenon lamp are shown. A color temperature cannot be used for these light source classification decision. Then, that classification is judged by preparing the sensor which newly has sensibility in a field with a wavelength of 700nm or more, and measuring the reinforcement of this field. Or that classification is judged by preparing the sensor which has sensibility in a minute field including the location of the bright line of a fluorescent lamp, and measuring the reinforcement of this field. A suitable approach is used for said approach according to classification distribution of the target light source.

[0028] Beforehand, to two or more sorts of ambient lights, the above-mentioned chrominance-signal processing information is searched for by the approach of mentioning later, and is stored in the chrominance-signal processing information storing section 312 two or more sorts. The signal transformation section 304 performs conversion shown in a degree type based on matrix XYZ12XYZ2 stored in the chrominance-signal processing information storing section 312.

[0029]

[External Character 2]

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix} = XYZ12XYZ2 \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

$$XYZ12XYZ2 = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

[0030] Above matrix XYZ12XYZ2 is a matrix for performing chrominance-signal processing corresponding to ambient-light classification.

[0031] The data (color conversion information from the chromaticity value and standard color space of the color temperature, luminescence brightness, and fluorescent substance of a monitor to the chrominance signal of device dependence etc.) about a monitor's color property are stored in the monitor profile 306.

[0032] Next, X2 Y2 Z2 obtained in the signal transformation section 304 X2 Y2 Z2 which is not dependent on a device in the XYZ-> monitor RGB transducer 305 based on the information on the monitor profile 306 that the signal is stored in the monitor property A signal to monitor device R2 G2 B-2 It changes into a signal. Conversion here is matrix MTXXYZ2RGB of 3x3 about conversion on the monitor RGB from XYZ first. It carries out by using.

[0033]

[External Character 3]

$$\begin{bmatrix} R_2' \\ G_2' \\ B_2' \end{bmatrix} = MTX_{XYZ2RGB} \begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix}$$

[0034] Next, in consideration of a monitor output gamma property, look apple table conversion is performed about RGB each signal.
[0035] R2 =LUTR (R2 ')
G2 =LUTG (G2 ')
B-2 =LUTB (B-2 ')
[0036] In addition, matrix MTXXYZ2RGB of 3x3 And the monitor output gamma property is stored in the monitor profile 306 as color conversion information from a standard color space to the chrominance signal of device dependence.
[0037] Then, R2 G2 B-2 The image [signal / top / monitoring screen] corresponding to the signal to the monitor having corresponded [delivery] is displayed.
[0038] With these procedures, a printed matter image can be displayed on a monitor so that it may be visible to the same color as printed matter under this observation environment.
[0039] Next, the case where an image is observed under a certain illumination light (ambient light) is taken for an example, and the creation approach of chrominance-signal transformation-matrix XYZ12XYZ2 as chrominance-signal processing information corresponding to the illumination light is described. XYZ12XYZ2 is obtained by the next matrix operation.
[0040]
[External Character 4]

$$XYZ12XYZ2 = M^{-1} \cdot D \cdot M \cdot CR$$

$$D = \begin{bmatrix} \frac{R_w}{R_{w1}} & 0 & 0 \\ 0 & \frac{G_w}{G_{w1}} & 0 \\ 0 & 0 & \frac{B_w}{B_{w1}} \end{bmatrix}$$

$$\begin{bmatrix} R_{w1} \\ G_{w1} \\ B_{w1} \end{bmatrix} = M \begin{bmatrix} X_{w1} \\ Y_{w1} \\ Z_{w1} \end{bmatrix}$$

$$\begin{bmatrix} R_w \\ G_w \\ B_w \end{bmatrix} = M \begin{bmatrix} X_w \\ Y_w \\ Z_w \end{bmatrix}$$

[0041] The aforementioned matrix M is a matrix which changes into the amount RGB of responses in the electric-eye (cone) level of human being's eyes the tristimulus values XYZ expressed with the CIEXYZ color coordinate system (a foundation and Asakura Publishing of color dynamics: refer to p.216 grade). Xw1Yw1Zw1 is the tristimulus values of an ambient light (observation environmental white). Moreover, Xw Yw Zw It is the tristimulus values of criteria white and asks by the degree type using tristimulus-values Xw1Yw1Zw1 of the above-mentioned ambient light (observation environmental white), and tristimulus-values Xw2Yw2Zw2 of monitor white.
[0042] Xw = (1-s) and Xw1+s-Xw2Yw = (1-s), Yw1+s-Yw2Zw = (1-s), and Zw1+s-Zw2 -- here -- Xw Yw Zw They are the tristimulus values of the white at the time of observing the image displayed on the monitor 307. When observing the image displayed on a monitoring screen, human being has not done full adaptation and has adapted himself to the monitor white chisel at monitor white and a rate which exists at both ambient lights. Therefore, if a monitor's white sets

to s the parameter (adaptation ratio) which shows the effect which carries out an observation environmental white pair, and which it has on criteria white when adapting itself variously [a monitor] namely, they are the tristimulus values Xw Yw Zw of a reference white. It can ask by the above-mentioned formula.
[0043] The adaptation ratio s changes with the color temperature of an ambient light, and the background colors (a monitor's background color) of an image. For example, when a background color makes it change on gray-scale level from black to white, the rate which adapts itself to an ambient light becomes large, so that a background color approaches black. The tristimulus values of an ambient light and the tristimulus values of monitor white were calculated using colorimetry equipments, such as a color luminance meter.
[0044] Matrix CR is a matrix changed into the color signal (X1 'Y1 'Z1 ') in consideration of the properties (the spectral characteristic, color rendering properties, etc.) of the light source (ambient light) of using the color signal (X1Y1 Z1) described using the standard color space (the standard light sources, such as D65 and D50, are used as the base in a standard color space.) at the time of observation. Here, the matrix of 3x3 was used as a matrix CR. The color signal (X1 'Y1 'Z1 ') in consideration of a light source property is acquired from the color signal (X1 Y1 Z1) described by the degree type in the standard color space using Matrix CR.
[0045]
[External Character 5]

$$\begin{bmatrix} X_1' \\ Y_1' \\ Z_1' \end{bmatrix} = CR \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

[0046] It asked for the actual multiplier of Matrix CR by optimizing using the attenuation least square method using the test chart which consists of a color patch of 77 colors as shown in drawing 2 , using as data the measurement value which calculated the tristimulus values under a certain illumination light by measurement, and the color signal value (tristimulus values) described using the standard color space. or the spectral reflectance of a color patch of 77 colors — a spectrophotometer — asking — this and a spectrum — the spectrum of the illumination light measured with the luminance meter — from intensity distribution, the tristimulus values under the illumination light were calculated, and the actual multiplier of Matrix CR was obtained using the optimization technique like the above. The above and a measurement means used the optimal means according to the case.
[0047] Matrix XYZ12XYZ2 is notionally constituted by two elements, Matrix CR and matrix M-1.D-M, as shown in drawing 9 .
[0048] Matrix CR is a matrix for changing into the color signal (X1 'Y1 'Z1 ') in consideration of the property of an ambient light (Xw1Yw1Zw1) the color signal (X1 Y1 Z1) described using the standard color space depending on the standard light source which was mentioned above, and which a scanner has like. That is, Matrix CR is X1 Y1 Z1 which was dependent on the standard light source based on the property of the light sources, such as color rendering properties. It changes into X1 'Y1 'Z1 ' depending on an ambient light.
[0049] And matrix M-1.D-M which is other elements is Von which is chromatic adaptation prediction theory. X2 Y2 Z2 which depended on criteria white for X1 'Y1 'Z1 ' which was dependent on the ambient light based on the theory of Kreis It changes.
[0050] Thus, good signal transformation which considered the properties (the spectral characteristic, color rendering property, etc.) of an ambient light and human being's chromatic adaptation (the criteria white in a monitor's image should be influenced of both monitor white and ambient-light white) can be performed by changing based on the property of an ambient light, next carrying out chromatic adaptation prediction first, based on observation environmental white and criteria white.
[0051] Therefore, the color vanity of an input image and the image displayed on the monitor 307 can be made in agreement.
[0052] (Operation gestalt 2) The operation gestalt by the configuration which formed the

chrominance-signal processing information operation part 314 as some systems as an operation gestalt 2 so that it might illustrate to drawing 3 is explained. With this operation gestalt, chrominance-signal processing information is not prepared beforehand, according to the ambient-light information acquired by the sensor 310, it is operation part 314 and chrominance-signal processing information is acquired. The next matrix operation which explained the operation which acquires chrominance-signal processing information as an approach of asking for the chrominance-signal transformation matrix of the operation gestalt 1 is performed.
[0053]
XYZ12XYZ2=M-1.D-M-CR [0054]
[External Character 6]

$$D = \begin{bmatrix} \frac{R_w}{R_{w1}} & 0 & 0 \\ 0 & \frac{G_w}{G_{w1}} & 0 \\ 0 & 0 & \frac{B_w}{B_{w1}} \end{bmatrix}$$

$$\begin{bmatrix} R_{w1} \\ G_{w1} \\ B_{w1} \end{bmatrix} = M \begin{bmatrix} X_{w1} \\ Y_{w1} \\ Z_{w1} \end{bmatrix}$$

$$\begin{bmatrix} R_w \\ G_w \\ B_w \end{bmatrix} = M \begin{bmatrix} X_w \\ Y_w \\ Z_w \end{bmatrix}$$

[0055] The aforementioned matrix M is a matrix which changes into the amount RGB of responses in the electric-eye (cone) level of human being's eyes the tristimulus values XYZ expressed with the CIEXYZ color coordinate system. Xw1Yw1Zw1 is the tristimulus values of an ambient light (observation environmental white). Moreover, Xw Yw Zw It is the tristimulus values of criteria white and asks by the degree type using tristimulus-values Xw2Yw2Zw2 of the tristimulus values of the above-mentioned ambient light (observation environmental white), and monitor white.
[0056] Xw = (1-s), Xw1+s-Xw2Yw = (1-s), Yw1+s-Yw2Zw = (1-s), and Zw1+s-Zw2s are parameters which show the effect which monitor white and observation environmental white have on a reference white. Although it was also possible to have calculated the tristimulus values of an ambient light and the tristimulus values of monitor white using colorimetry equipments, such as a color luminance meter, and to have inputted a value into a system, the tristimulus values of an ambient light used the value acquired from a sensor 310 here. For the reason, the sensor 310 considered as the equipment configuration which outputs ambient-light information as tristimulus-values Xw0Yw0Zw0. Tristimulus-values Xw0Yw0Zw0 expresses the color (white) of the ambient light at that time. This equipment was made into the circuitry using three photosensors with the different spectral sensitivity characteristic shown in drawing 6 . According to each spectral sensitivity characteristic, output Rs0Gs0Bs0 is obtained from three photosensors. The spectral sensitivity characteristic for acquiring tristimulus values XYZ is shown in drawing 7 , and differs from the spectral sensitivity characteristic (drawing 6) of the sensor used with this equipment. Therefore, the conversion to tristimulus-values Xw0Yw0Zw0 from sensor output Rs0Gs0Bs0 is required. With this operation gestalt, the degree type performed the conversion using the matrix MTXsenser of 3x3.
[0057]
[External Character 7]

$$\begin{bmatrix} X_{w0} \\ Y_{w0} \\ Z_{w0} \end{bmatrix} = MTX_{senser} \begin{bmatrix} R_{s0} \\ G_{s0} \\ B_{s0} \end{bmatrix}$$

[0058] The above-mentioned matrix operation was performed by the digital digital disposal circuit constituted in equipment.
[0059] Matrix CR is a matrix changed into the color signal (X'Y'Z') in consideration of the properties (the spectral characteristic, color rendering properties, etc.) of the light source (ambient light) of using the color signal (XYZ) described using the standard color space (the standard light sources, such as D65 and D50, are used as the base in a standard color space.) at the time of observation. Here, the matrix of 3x3 was used as a matrix CR. The color signal (X'Y'Z') in consideration of a light source property is acquired from the color signal (XYZ) described by the degree type in the standard color space using Matrix CR.
[0060]
[External Character 8]

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = CR \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

[0061] It asked for the actual multiplier of Matrix CR by optimizing using the attenuation least square method using the test chart which consists of a color patch of 77 colors as shown in drawing 2 , using as data the measurement value which calculated the tristimulus values under a certain illumination light by measurement, and the color signal value (tristimulus values) described using the standard color space. or the spectral reflectance of a color patch of 77 colors — a spectrophotometer — asking — this and a spectrum — the spectrum of the illumination light measured with the luminance meter — from intensity distribution, the tristimulus values under the illumination light were calculated, and the actual multiplier of Matrix CR was obtained using the optimization technique like the above. The above and a measurement means used the optimal means according to the case.
[0062] The matrix CR created as mentioned above carried out storage preservation as ambient-light property amendment information at the ambient-light property amendment information storing section 313.
[0063] It is the ambient-light classification decision section 311, and as the operation gestalt 1 explained the matrix CR used in the case of an operation, it makes a classification judgment, using this ambient-light classification information, it chooses from the ambient-light property amendment information storing section 313 the ambient-light property amendment information that it corresponds, based on the ambient-light information acquired from a sensor 310, and uses it for it.
[0064] Actuation which explained other actuation with the operation gestalt 1 is performed mostly.
[0065] Since it considered as the configuration which searches for the chrominance-signal processing information that it actually uses in the signal transformation section 304, by the operation with this operation gestalt at the chrominance-signal processing information operation part 314 The number of classification of the chrominance-signal processing information independent of a monitor for which it does not depend on the chromaticity or brightness of an ambient light like, which carries out preparation storage beforehand and which is placed compared with the operation gestalt 1 since what is necessary is just coming to prepare chrominance-signal processing information beforehand as ambient-light property amendment information like can be liked and lost.
[0066] (Operation gestalt 3) The operation gestalt by the configuration which formed the ambient-light classification directions section 315 as some systems as an operation gestalt 3 so that it might illustrate to drawing 8 is explained.

[0067] Basic actuation of this operation gestalt is almost the same as the actuation explained with the operation gestalt 1. Although the system considered as the configuration which obtains ambient-light classification automatically in the ambient-light classification decision section 311 in a system in the operation gestalt 1 using the ambient-light information acquired by the sensor 310, ambient-light classification was considered as the configuration directed directly by having formed the ambient-light classification directions section 315 with this operation gestalt. Thereby, taking ambient-light classification is avoided. Moreover, the image in ambient lights other than under [of the present] an environment which may be observed can be displayed on a monitor. Directions of ambient-light classification were performed by choosing the ambient-light number by which it was indicated by the list on the screen by the mouse or the keyboard. At this time, it also made it possible to display a color temperature and the spectral characteristic on a screen as information on directions decision.
[0068] When a large number [the color which may be perceived in an observation environment] so that each operation gestalt shown until now may see , in case synthesize such white , it ask for criteria white , chrominance signal processing be performed using this criteria white and color vanity of the display object and printed matter on a monitor be made the same , a color signal be changed fully in consideration of the properties (the spectral characteristic , color rendering properties , etc.) of an ambient light .
[0069] While searching for the information (a chromaticity value, XYZ tristimulus values, etc.) about the white (it is the white of paper under the illumination light) perceived in the illumination light (ambient light) in detail from the information (spectrum a chromaticity value, a color temperature, or reinforcement (illuminance)) about the illumination light (ambient light), the information (for example, two-dimensional matrix etc.) which changes other colors is acquired, and chrominance-signal conversion is performed using such information.
[0070] According to each above-mentioned example, corresponding to various ambient-light light sources, a color signal can be changed with a sufficient precision, and it becomes possible about the display object and printed matter on a monitor to obtain the same vanity in sufficient precision.
[0071] In addition, at each above-mentioned operation gestalt, it is Von. Although the theory of Kreis was used as chromatic adaptation prediction theory, other chromatic adaptation prediction theory may be applied.
[0072] Moreover, this invention is applicable to the sequence processing according to various hard configurations and them. these sequence processings — for example, — logic — it is algorithm-ized in the range which are-izing [the range], or is software-ized or does not deviate from the main point of above-mentioned this invention, and can apply as hardware or equipment according to this algorithm.
[0073] Moreover, this invention can be used for a copying machine, a printer, etc. with [possessing the function which displays the image printed on a monitor beforehand] a pre viewer function. Furthermore, it can use also for the image processing system which performs chrominance-signal conversion in all cases, such as using this invention in the case of chrominance-signal conversion of various input/output equipment as an art of a color management system.
[0074]
[Effect of the Invention] According to this invention, the vanity of the color of an output image can be doubled with an input image irrespective of an ambient light (observation light) at the appearance explained above.
[0075] Moreover, the vanity of the color of an output image can be doubled with an input image with high precision by color conversion considered to the property of ambient lights, such as color rendering properties.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the image processing system and approach of performing ****** based on an ambient light.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A color picture product spreads in recent years, and a color picture can be easily treated now also not only in special fields, such as design creation using CG, but in general office. By the way, it was difficult for both color not to suit, when the image created on the monitor is generally outputted by the printer, but to perform color examination of a print object on a monitor. As an approach for solving this, a color management system is devised and attracts attention.
[0003] A color management system loses the difference in the color for every device by using a common color space. If this is a color described with the same coordinate in the same color space, it tends to obtain coincidence of the vanity of a color by expressing all colors on the basis of the idea that the vanity of those colors is the same in the same color space, and making the corresponding coordinate in agreement with it. There is the approach of amending the difference for every device as one of the approaches generally used now using the XYZ tristimulus values which are the internal description coordinate value, using a CIE-XYZ color space as a color space.
[0004] The environment where an image is observed using drawing 11 is explained. The case where printed matter 201 and the same image 202 are displayed on a monitor 203 here is shown, and the ambient light 204 when observing the image serves as structure detected by the ambient-light sensor 206 installed on the monitor or the printer.
[0005] For example, neither the printed image nor the image displayed on CRT is observed under the always regular ambient light, but the ambient light 204 of drawing 11 changes with environmental situations. Furthermore, it is the basis of a certain ambient light, and even if it can carry out color matching, if the ambient light changes, it will be visible [the image which was in agreement until now] to an image which is generally completely different. In order to avoid this, as the above-mentioned color management system is used and it is shown in drawing 10 , in case it observes in a certain environment, each image becomes what kind of value (for example, XYZ value), or it predicts based on the information 108 on the ambient light beforehand obtained from the sensor 109, and it is possible to double the vanity of a color reproducing the value using the profile 103,106 for every device as faithfully as possible.
[0006] This approach is explained using drawing 10 . First, R1 G1 B1 which reads an input image (printed matter) with a scanner 101, and is obtained from a scanner in the scanner RGB->XYZ transducer 102 using the scanner profile data 103 with which the scanner property data provided beforehand are stored Chrominance-signal X1 Y1 Z1 which does not depend for a value on a device It changes. Furthermore, chrominance-signal value X2 Y2 Z2 for every color at the time of observing under the ambient light based on the ambient-light information 108 acquired from the sensor 109 which senses an ambient light in the signal transformation section It changes. And R2 G2 B-2 which is [in / using the monitor profile 106 / the XYZ-> monitor RGB transducer 105] a monitor input value It computes.
[0007] Using the approaches above originally, if it becomes the same value on a common color space, it must be visible to the same color. However, when comparing the color obtained by illuminating like the color displayed on the monitor, and printed matter, even if they are the same values, it is known by the observer that it is not visible to the same color. Therefore, in the

above environments, in order to observe visually and to enable it to perceive the same color, the further amendment is needed.

[0008] Human being is considered to recognize all colors by the comparison with the white on the basis of white when observing a color. The case where the display object and printed matter on the monitor which set on the basis of a certain ambient light (ambient light) are observed is considered for an example.

[0009] The color considered to be much white, such as white (white of paper) of the image illuminated by the white and the illumination light of the white and illumination light of a monitor, (perceived) is in such an environment. The observer who is in it synthesizes the consciousness about the white in the environment of above-mentioned many, and gets the white which becomes the criteria when seeing a color. And it is thought that the color is observed on the basis of the white. For this reason, it asks for the white which becomes criteria into the above environments, and how to double vanity with a color can be considered by changing the color of all images using this reference white. As an application of the above-mentioned approach, there is an approach described by the paper (SPIE Publication Vol.2170pp170.-181.). In this paper, the bottom of a fluorescent lamp is asked for criteria white based on a monitor's white and the white of a fluorescent lamp, and color transform processing in consideration of color vanity is performed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the vanity of the color of an output image can be doubled with an input image irrespective of an ambient light (observation light) at the appearance explained above.
[0075] Moreover, the vanity of the color of an output image can be doubled with an input image with high precision by color conversion considered to the property of ambient lights, such as color rendering properties.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By asking for the white which becomes the above-mentioned criteria, and changing the color of all images using this reference white, when the approach of doubling the vanity of a color has the high color rendering properties of the illumination light, that effectiveness is fully acquired. However, if the spectral distributions of the illumination light generally differ, in the colour stimulus specification obtained, change of the colour stimulus specification will change variously in things according to spectral-reflectance distribution of a reflective object further. Therefore, vanity of a color cannot fully be simply doubled only by the approach of performing color conversion of all images on the basis of a certain white.
[0011] This invention is made in view of an above-mentioned point, and it aims at doubling the vanity of the color of an output image with an input image irrespective of an ambient light (observation light).
[0012] Moreover, it aims at doubling the vanity of the color of an output image with an input image with high precision by color conversion considered to the property of ambient lights, such as color rendering properties.

[Translation done.]

MEANS

[Means for Solving the Problem] It has the following configurations, in order to attain the above-mentioned purpose.
[0014] This application the 1st invention is the image-processing approach which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The image data which shows the input image obtained with the input device under the standard light source of arbitration Color conversion is carried out at the image data depending on the observation light source, color conversion of the image data depending on this observation light source is carried out based on the criteria white at the time of observation, and it is characterized by outputting the image data depending on the criteria white at the time of said observation to an image output unit.
[0015] Moreover, it is the image-processing approach which carries out color conversion of the image data which shows this input image so that this application the 2nd invention doubles with an input image the vanity of the color of the output image reproduced with an image output unit, and it is characterized by to carry out color conversion at the image data which considered the chromatic adaptation based on the property of an ambient light, and the criteria white at the time of observation for the image data which shows the input image obtained with the input device under the standard light source of arbitration.
[0016] Moreover, this application the 3rd invention is an image processing system which carries out color conversion of the image data which shows this input image in order to double with an input image the vanity of the color of the output image reproduced with an image output unit. The 1st color conversion means which carries out color conversion of the image data which shows the input image obtained with the input device under the standard light source of arbitration at the image data depending on the observation light source, It is characterized by having the 2nd color conversion means which carries out color conversion of the image data depending on this observation light source based on the criteria white at the time of observation, and an output means to output the image data depending on the criteria white at the time of said observation to an image output unit.
[0017] Moreover, a setting means for this application the 4th invention to be an image processing system which performs chrominance-signal conversion to image data as color vanity of the display object and printed matter on a monitor is made the same, and to set up the class of ambient light, A storage means to store beforehand the chrominance-signal processing information corresponding to ambient-light classification, It is characterized by having a chrominance-signal conversion means to perform chrominance-signal conversion which considered the chromatic adaptation based on the property of this ambient light, and a monitor's white to said image data, based on the chrominance-signal processing information corresponding to the classification of said set-up ambient light.
[0018]
[Embodiment of the Invention]
(Operation gestalt 1) Drawing 1 is drawing having shown the data flow of the operation gestalt 1. Drawing 1 read printed matter with the scanner, and showed the case where it was displayed on

a monitor that it is visible to the same color as printed matter.

[0019] An input image (printed matter) is first read with a scanner, and it is made a picture signal. R1 G1 B1 obtained from the scanner 301 X1 Y1 Z1 which is not dependent on a device in the scanner RGB->XYZ transducer 302 based on the information on the scanner profile 303 that data are stored in the scanner property It changes.

[0020] Conversion here performs look-up table conversion about RGB each signal in consideration of an input gamma property first.

[0021] R1 '=LUTR (R1)

G1 '=LUTG (G1)

B1 '=LUTB (B1)

[0022] Next, it is matrix MTXRGB2XYZ of 3x3 about the conversion to XYZ from Scanner RGB. It carries out by using.

[0023]

[External Character 1]

$$\begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix} = MTX_{RGB2XYZ} \begin{bmatrix} R_1' \\ G_1' \\ B_1' \end{bmatrix}$$

[0024] The color space used here is not restricted to a XYZ color space, and as long as it is the color space which can be absorbing the difference in a device, what kind of color space may be used (for example, CIELUV, CIELAB, etc.).

[0025] The data (as shown above, they are a color transformation matrix (RGB->XYZ), LUT, etc.) about the color property of a scanner are stored in the scanner profile 303.

[0026] Furthermore, X1 Y1 Z1 obtained A signal is set in the signal transformation section 304. Read the chrominance-signal processing information (in detail the two-dimensional matrix XYZ12 of 3x3 XYZ2) corresponding to the ambient-light classification obtained in the ambient-light classification decision section 311 based on the ambient-light information acquired by the sensor 310 from the chrominance-signal processing information storing section 312, and signal processing is performed. X2 Y2 Z2 considered as printed matter and the display object on a monitor giving the same color vanity under this observation environment It changes.

[0027] The spectral distribution of a CIE standard illuminant (A, C, D65) and an auxiliary standard illuminant B are shown in <u>drawing 4</u> as an ambient light. Since the color temperatures differ, these light sources take a color temperature as ambient-light information, and judge the classification. Moreover, the spectral distribution of the fluorescent lamp used for <u>drawing 5</u> as the typical common light source D65, standard illuminant C, and a xenon lamp are shown. A color temperature cannot be used for these light source classification decision. Then, that classification is judged by preparing the sensor which newly has sensibility in a field with a wavelength of 700nm or more, and measuring the reinforcement of this field. Or that classification is judged by preparing the sensor which has sensibility in a minute field including the location of the bright line of a fluorescent lamp, and measuring the reinforcement of this field. A suitable approach is used for said approach according to classification distribution of the target light source.

[0028] Beforehand, to two or more sorts of ambient lights, the above-mentioned chrominance-signal processing information is searched for by the approach of mentioning later, and is stored in the chrominance-signal processing information storing section 312 two or more sorts. The signal transformation section 304 performs conversion shown in a degree type based on matrix XYZ12XYZ2 stored in the chrominance-signal processing information storing section 312.

[0029]

[External Character 2]

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix} = XYZ12XYZ2 \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

$$XYZ12XYZ2 = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

[0030] Above matrix XYZ12XYZ2 is a matrix for performing chrominance-signal processing corresponding to ambient-light classification.
[0031] The data (color conversion information from the chromaticity value and standard color space of the color temperature, luminescence brightness, and fluorescent substance of a monitor to the chrominance signal of device dependence etc.) about a monitor's color property are stored in the monitor profile 306.
[0032] Next, X2 Y2 Z2 obtained in the signal transformation section 304 X2 Y2 Z2 which is not dependent on a device in the XYZ-> monitor RGB transducer 305 based on the information on the monitor profile 306 that the signal is stored in the monitor property A signal to monitor device R2 G2 B-2 It changes into a signal. Conversion here is matrix MTXXYZ2RGB of 3x3 about conversion on the monitor RGB from XYZ first. It carries out by using.
[0033]
[External Character 3]

$$\begin{bmatrix} R_2' \\ G_2' \\ B_2' \end{bmatrix} = MTX_{XYZ2RGB} \begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \end{bmatrix}$$

[0034] Next, in consideration of a monitor output gamma property, look apple table conversion is performed about RGB each signal.
[0035] R2 =LUTR (R2 ')
G2 =LUTG (G2 ')
B-2 =LUTB (B-2 ')
[0036] In addition, matrix MTXXYZ2RGB of 3x3 And the monitor output gamma property is stored in the monitor profile 306 as color conversion information from a standard color space to the chrominance signal of device dependence.
[0037] Then, R2 G2 B-2 The image [signal / top / monitoring screen] corresponding to the signal to the monitor having corresponded [delivery] is displayed.
[0038] With these procedures, a printed matter image can be displayed on a monitor so that it may be visible to the same color as printed matter under this observation environment.
[0039] Next, the case where an image is observed under a certain illumination light (ambient light) is taken for an example, and the creation approach of chrominance-signal transformation-matrix XYZ12XYZ2 as chrominance-signal processing information corresponding to the illumination light is described. XYZ12XYZ2 is obtained by the next matrix operation.
[0040]
[External Character 4]

XYZ12XYZ2$=M^{-1}\cdot D\cdot M\cdot CR$

$$D=\begin{bmatrix}\frac{R_w}{R_{w1}} & 0 & 0\\ 0 & \frac{G_w}{G_{w1}} & 0\\ 0 & 0 & \frac{B_w}{B_{w1}}\end{bmatrix}$$

$$\begin{bmatrix}R_{w1}\\ G_{w1}\\ B_{w1}\end{bmatrix}=M\begin{bmatrix}X_{w1}\\ Y_{w1}\\ Z_{w1}\end{bmatrix}$$

$$\begin{bmatrix}R_w\\ G_w\\ B_w\end{bmatrix}=M\begin{bmatrix}X_w\\ Y_w\\ Z_w\end{bmatrix}$$

[0041] The aforementioned matrix M is a matrix which changes into the amount RGB of responses in the electric-eye (cone) level of human being's eyes the tristimulus values XYZ expressed with the CIEXYZ color coordinate system (a foundation and Asakura Publishing of color dynamics: refer to p.216 grade). Xw1Yw1Zw1 is the tristimulus values of an ambient light (observation environmental white). Moreover, Xw Yw Zw It is the tristimulus values of criteria white and asks by the degree type using tristimulus-values Xw1Yw1Zw1 of the above-mentioned ambient light (observation environmental white), and tristimulus-values Xw2Yw2Zw2 of monitor white.

[0042] Xw = (1-s) and Xw1+s-Xw2Yw = (1-s), Yw1+s-Yw2Zw = (1-s), and Zw1+s-Zw2 -- here -- Xw Yw Zw They are the tristimulus values of the white at the time of observing the image displayed on the monitor 307. When observing the image displayed on a monitoring screen, human being has not done full adaptation and has adapted himself to the monitor white chisel at monitor white and a rate which exists at both ambient lights. Therefore, if a monitor's white sets to s the parameter (adaptation ratio) which shows the effect which carries out an observation environmental white pair, and which it has on criteria white when adapting itself variously [a monitor] namely, they are the tristimulus values Xw Yw Zw of a reference white. It can ask by the above-mentioned formula.

[0043] The adaptation ratio s changes with the color temperature of an ambient light, and the background colors (a monitor's background color) of an image. For example, when a background color makes it change on gray-scale level from black to white, the rate which adapts itself to an ambient light becomes large, so that a background color approaches black. The tristimulus values of an ambient light and the tristimulus values of monitor white were calculated using colorimetry equipments, such as a color luminance meter.

[0044] Matrix CR is a matrix changed into the color signal (X1 'Y1 'Z1 ') in consideration of the properties (the spectral characteristic, color rendering properties, etc.) of the light source (ambient light) of using the color signal (X1Y1 Z1) described using the standard color space (the standard light sources, such as D65 and D50, are used as the base in a standard color space.) at the time of observation. Here, the matrix of 3x3 was used as a matrix CR. The color signal (X1 'Y1 'Z1 ') in consideration of a light source property is acquired from the color signal (X1 Y1 Z1) described by the degree type in the standard color space using Matrix CR.

[0045]

[External Character 5]

$$\begin{bmatrix} X_1' \\ Y_1' \\ Z_1' \end{bmatrix} = CR \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \end{bmatrix}$$

[0046] It asked for the actual multiplier of Matrix CR by optimizing using the attenuation least square method using the test chart which consists of a color patch of 77 colors as shown in drawing 2 , using as data the measurement value which calculated the tristimulus values under a certain illumination light by measurement, and the color signal value (tristimulus values) described using the standard color space. or the spectral reflectance of a color patch of 77 colors — a spectrophotometer — asking — this and a spectrum — the spectrum of the illumination light measured with the luminance meter — from intensity distribution, the tristimulus values under the illumination light were calculated, and the actual multiplier of Matrix CR was obtained using the optimization technique like the above. The above and a measurement means used the optimal means according to the case.
[0047] Matrix XYZ12XYZ2 is notionally constituted by two elements, Matrix CR and matrix M-1.D-M, as shown in drawing 9 .
[0048] Matrix CR is a matrix for changing into the color signal (X1 'Y1 'Z1 ') in consideration of the property of an ambient light (Xw1Yw1Zw1) the color signal (X1 Y1 Z1) described using the standard color space depending on the standard light source which was mentioned above, and which a scanner has like. That is, Matrix CR is X1 Y1 Z1 which was dependent on the standard light source based on the property of the light sources, such as color rendering properties. It changes into X1 'Y1 'Z1 ' depending on an ambient light.
[0049] And matrix M-1.D-M which is other elements is Von which is chromatic adaptation prediction theory. X2 Y2 Z2 which depended on criteria white for X1 'Y1 'Z1 ' which was dependent on the ambient light based on the theory of Kreis It changes.
[0050] Thus, good signal transformation which considered the properties (the spectral characteristic, color rendering property, etc.) of an ambient light and human being's chromatic adaptation (the criteria white in a monitor's image should be influenced of both monitor white and ambient-light white) can be performed by changing based on the property of an ambient light, next carrying out chromatic adaptation prediction first, based on observation environmental white and criteria white.
[0051] Therefore, the color vanity of an input image and the image displayed on the monitor 307 can be made in agreement.
[0052] (Operation gestalt 2) The operation gestalt by the configuration which formed the chrominance-signal processing information operation part 314 as some systems as an operation gestalt 2 so that it might illustrate to drawing 3 is explained. With this operation gestalt, chrominance-signal processing information is not prepared beforehand, according to the ambient-light information acquired by the sensor 310, it is operation part 314 and chrominance-signal processing information is acquired. The next matrix operation which explained the operation which acquires chrominance-signal processing information as an approach of asking for the chrominance-signal transformation matrix of the operation gestalt 1 is performed.
[0053]
XYZ12XYZ2=M-1.D-M-CR [0054]
[External Character 6]

$$D=\begin{bmatrix}\frac{R_w}{R_{w1}} & 0 & 0\\ 0 & \frac{G_w}{G_{w1}} & 0\\ 0 & 0 & \frac{B_w}{B_{w1}}\end{bmatrix}$$

$$\begin{bmatrix}R_{w1}\\G_{w1}\\B_{w1}\end{bmatrix}=M\begin{bmatrix}X_{w1}\\Y_{w1}\\Z_{w1}\end{bmatrix}$$

$$\begin{bmatrix}R_w\\G_w\\B_w\end{bmatrix}=M\begin{bmatrix}X_w\\Y_w\\Z_w\end{bmatrix}$$

[0055] The aforementioned matrix M is a matrix which changes into the amount RGB of responses in the electric-eye (cone) level of human being's eyes the tristimulus values XYZ expressed with the CIEXYZ color coordinate system. Xw1Yw1Zw1 is the tristimulus values of an ambient light (observation environmental white). Moreover, Xw Yw Zw It is the tristimulus values of criteria white and asks by the degree type using tristimulus-values Xw2Yw2Zw2 of the tristimulus values of the above-mentioned ambient light (observation environmental white), and monitor white.
[0056] Xw = (1-s), Xw1+s-Xw2Yw = (1-s), Yw1+s-Yw2Zw = (1-s), and Zw1+s-Zw2s are parameters which show the effect which monitor white and observation environmental white have on a reference white. Although it was also possible to have calculated the tristimulus values of an ambient light and the tristimulus values of monitor white using colorimetry equipments, such as a color luminance meter, and to have inputted a value into a system, the tristimulus values of an ambient light used the value acquired from a sensor 310 here. For the reason, the sensor 310 considered as the equipment configuration which outputs ambient-light information as tristimulus-values Xw0Yw0Zw0. Tristimulus-values Xw0Yw0Zw0 expresses the color (white) of the ambient light at that time. This equipment was made into the circuitry using three photosensors with the different spectral sensitivity characteristic shown in drawing 6 . According to each spectral sensitivity characteristic, output Rs0Gs0Bs0 is obtained from three photosensors. The spectral sensitivity characteristic for acquiring tristimulus values XYZ is shown in drawing 7 , and differs from the spectral sensitivity characteristic (drawing 6) of the sensor used with this equipment. Therefore, the conversion to tristimulus-values Xw0Yw0Zw0 from sensor output Rs0Gs0Bs0 is required. With this operation gestalt, the degree type performed the conversion using the matrix MTXsenser of 3x3.
[0057]
[External Character 7]

$$\begin{bmatrix}X_{w0}\\Y_{w0}\\Z_{w0}\end{bmatrix}=MTX_{senser}\begin{bmatrix}R_{s0}\\G_{s0}\\B_{s0}\end{bmatrix}$$

[0058] The above-mentioned matrix operation was performed by the digital digital disposal circuit constituted in equipment.
[0059] Matrix CR is a matrix changed into the color signal (X'Y'Z') in consideration of the properties (the spectral characteristic, color rendering properties, etc.) of the light source (ambient light) of using the color signal (XYZ) described using the standard color space (the standard light sources, such as D65 and D50, are used as the base in a standard color space.) at the time of observation. Here, the matrix of 3x3 was used as a matrix CR. The color signal

(X'Y'Z') in consideration of a light source property is acquired from the color signal (XYZ) described by the degree type in the standard color space using Matrix CR.
[0060]
[External Character 8]

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = CR \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

[0061] It asked for the actual multiplier of Matrix CR by optimizing using the attenuation least square method using the test chart which consists of a color patch of 77 colors as shown in drawing 2 , using as data the measurement value which calculated the tristimulus values under a certain illumination light by measurement, and the color signal value (tristimulus values) described using the standard color space. or the spectral reflectance of a color patch of 77 colors — a spectrophotometer — asking — this and a spectrum — the spectrum of the illumination light measured with the luminance meter — from intensity distribution, the tristimulus values under the illumination light were calculated, and the actual multiplier of Matrix CR was obtained using the optimization technique like the above. The above and a measurement means used the optimal means according to the case.
[0062] The matrix CR created as mentioned above carried out storage preservation as ambient-light property amendment information at the ambient-light property amendment information storing section 313.
[0063] It is the ambient-light classification decision section 311, and as the operation gestalt 1 explained the matrix CR used in the case of an operation, it makes a classification judgment, using this ambient-light classification information, it chooses from the ambient-light property amendment information storing section 313 the ambient-light property amendment information that it corresponds, based on the ambient-light information acquired from a sensor 310, and uses it for it.
[0064] Actuation which explained other actuation with the operation gestalt 1 is performed mostly.
[0065] Since it considered as the configuration which searches for the chrominance-signal processing information that it actually uses in the signal transformation section 304, by the operation with this operation gestalt at the chrominance-signal processing information operation part 314 The number of classification of the chrominance-signal processing information independent of a monitor for which it does not depend on the chromaticity or brightness of an ambient light like, which carries out preparation storage beforehand and which is placed compared with the operation gestalt 1 since what is necessary is just coming to prepare chrominance-signal processing information beforehand as ambient-light property amendment information like can be liked and lost.
[0066] (Operation gestalt 3) The operation gestalt by the configuration which formed the ambient-light classification directions section 315 as some systems as an operation gestalt 3 so that it might illustrate to drawing 8 is explained.
[0067] Basic actuation of this operation gestalt is almost the same as the actuation explained with the operation gestalt 1. Although the system considered as the configuration which obtains ambient-light classification automatically in the ambient-light classification decision section 311 in a system in the operation gestalt 1 using the ambient-light information acquired by the sensor 310, ambient-light classification was considered as the configuration directed directly by having formed the ambient-light classification directions section 315 with this operation gestalt. Thereby, taking ambient-light classification is avoided. Moreover, the image in ambient lights other than under [of the present] an environment which may be observed can be displayed on a monitor. Directions of ambient-light classification were performed by choosing the ambient-light number by which it was indicated by the list on the screen by the mouse or the keyboard. At this time, it also made it possible to display a color temperature and the spectral characteristic on a screen as information on directions decision.

[0068] When a large number [the color which may be perceived in an observation environment] so that each operation gestalt shown until now may see , in case synthesize such white , it ask for criteria white , chrominance signal processing be performed using this criteria white and color vanity of the display object and printed matter on a monitor be made the same , a color signal be changed fully in consideration of the properties (the spectral characteristic , color rendering properties , etc.) of an ambient light .

[0069] While searching for the information (a chromaticity value, XYZ tristimulus values, etc.) about the white (it is the white of paper under the illumination light) perceived in the illumination light (ambient light) in detail from the information (spectrum a chromaticity value, a color temperature, or reinforcement (illuminance)) about the illumination light (ambient light), the information (for example, two-dimensional matrix etc.) which changes other colors is acquired, and chrominance-signal conversion is performed using such information.

[0070] According to each above-mentioned example, corresponding to various ambient-light light sources, a color signal can be changed with a sufficient precision, and it becomes possible about the display object and printed matter on a monitor to obtain the same vanity in sufficient precision.

[0071] In addition, at each above-mentioned operation gestalt, it is Von. Although the theory of Kreis was used as chromatic adaptation prediction theory, other chromatic adaptation prediction theory may be applied.

[0072] Moreover, this invention is applicable to the sequence processing according to various hard configurations and them. these sequence processings — for example, — logic — it is algorithm-ized in the range which are-izing [the range], or is software-ized or does not deviate from the main point of above-mentioned this invention, and can apply as hardware or equipment according to this algorithm.

[0073] Moreover, this invention can be used for a copying machine, a printer, etc. with [possessing the function which displays the image printed on a monitor beforehand] a pre viewer function. Furthermore, it can use also for the image processing system which performs chrominance-signal conversion in all cases, such as using this invention in the case of chrominance-signal conversion of various input/output equipment as an art of a color management system.

[Translation done.]

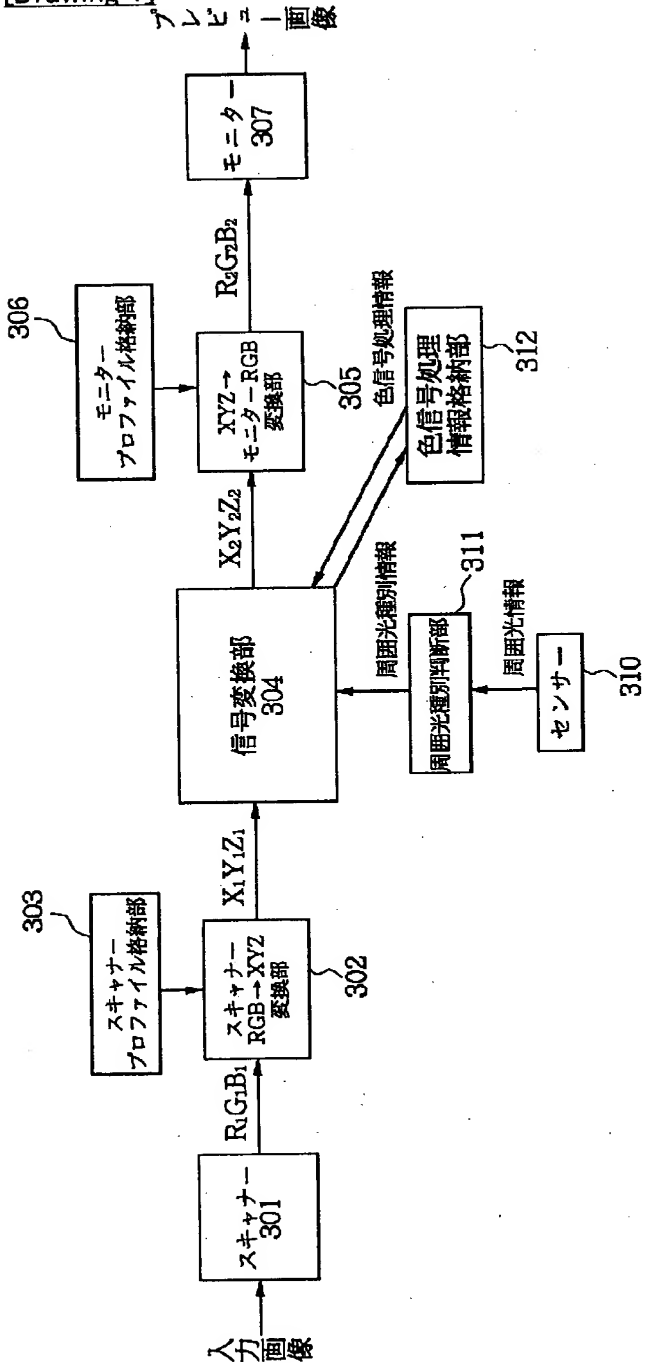
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing having shown the operation gestalt 1.
[Drawing 2] It is drawing which was used in order to obtain the multiplier of Matrix CR stated to the operation gestalt 1 and in which having shown the test chart which consists of a color patch of 77 colors.
[Drawing 3] It is drawing having shown the operation gestalt 2.
[Drawing 4] It is drawing having shown the CIE standard illuminant (A, C, D65) as an example of an ambient light, and the spectral distribution of an auxiliary standard illuminant B.
[Drawing 5] They are the fluorescent lamp used as the typical common light source D65 as an example of an ambient light, standard illuminant C, and drawing having shown the spectral distribution of a xenon lamp.
[Drawing 6] It is drawing showing the spectral sensitivity characteristic of the sensor used with the operation gestalt.
[Drawing 7] It is drawing showing the spectral sensitivity characteristic for calculating tristimulus values XYZ.
[Drawing 8] It is drawing having shown the operation gestalt 3.
[Drawing 9] It is drawing showing the data flow in the signal transformation section 304.
[Drawing 10] It is drawing having shown the conventional example.
[Drawing 11] It is drawing having shown the observation environment of an image.

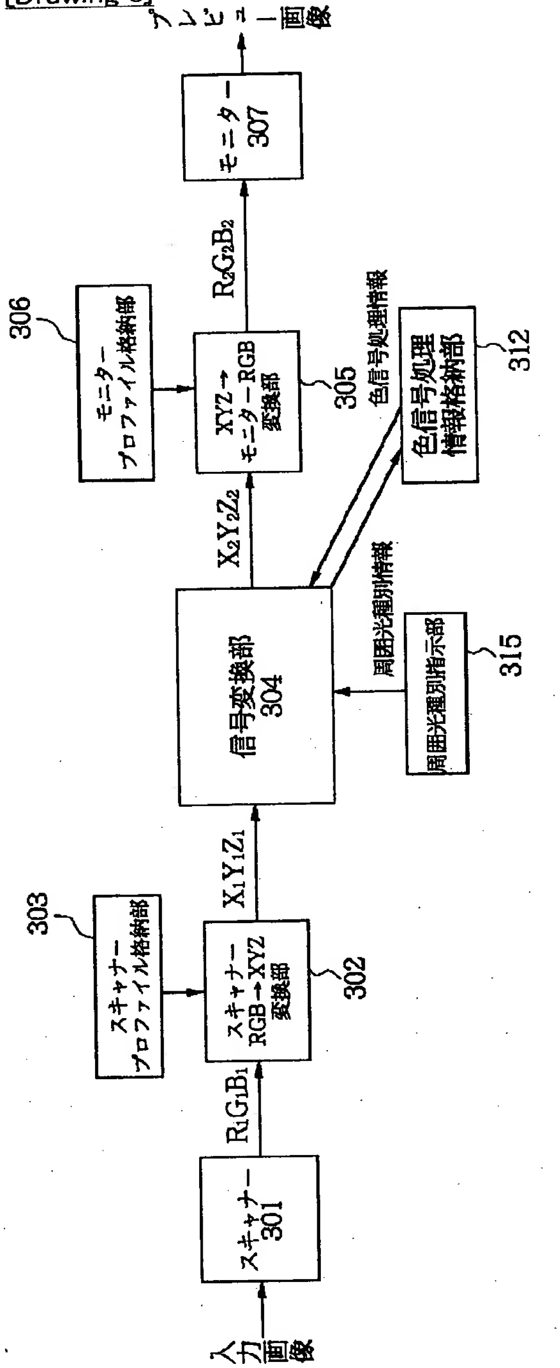
[Translation done.]

DRAWINGS

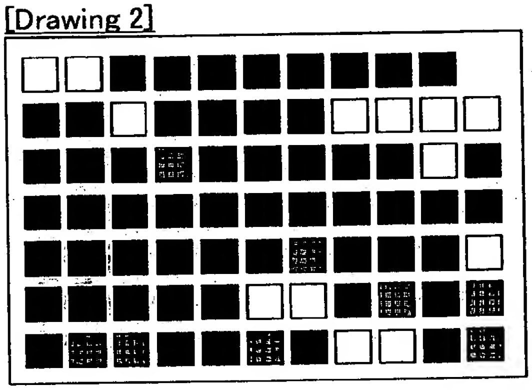
[Drawing 1]



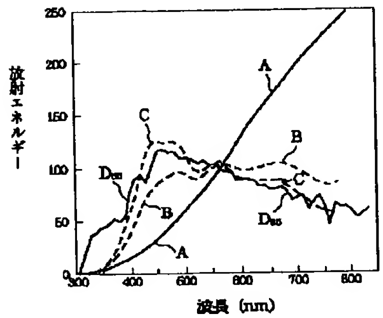
[Drawing 8]



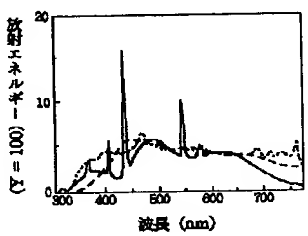
[Drawing 2]



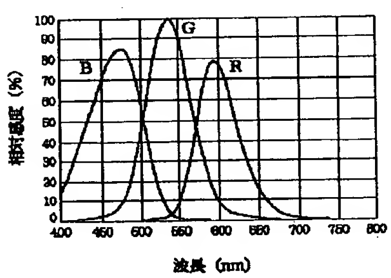
[Drawing 4]
標準の光A、D65、C及び補助標準の光Bの分光分布



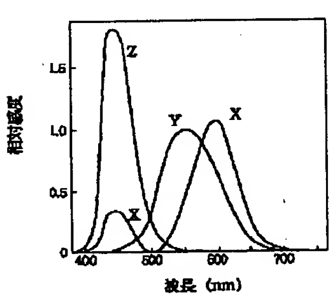
[Drawing 5]
代表的な常用光源D65として用いる蛍光ランプ（実線）、標準の光C（破線）、キセノンランプ（点線）の分光分布



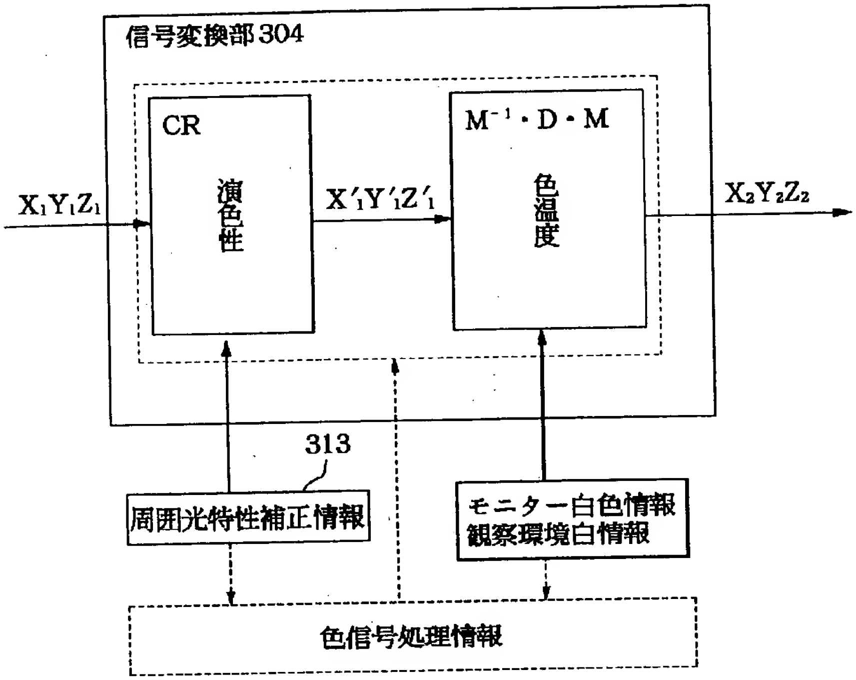
[Drawing 6]
センサ分光感度特性



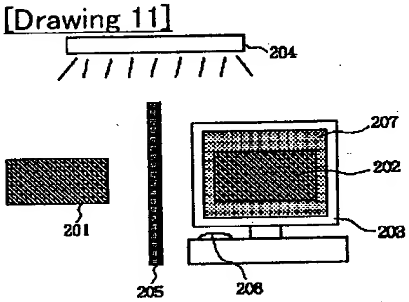
[Drawing 7]
三刺激値を得るための分光感度特性



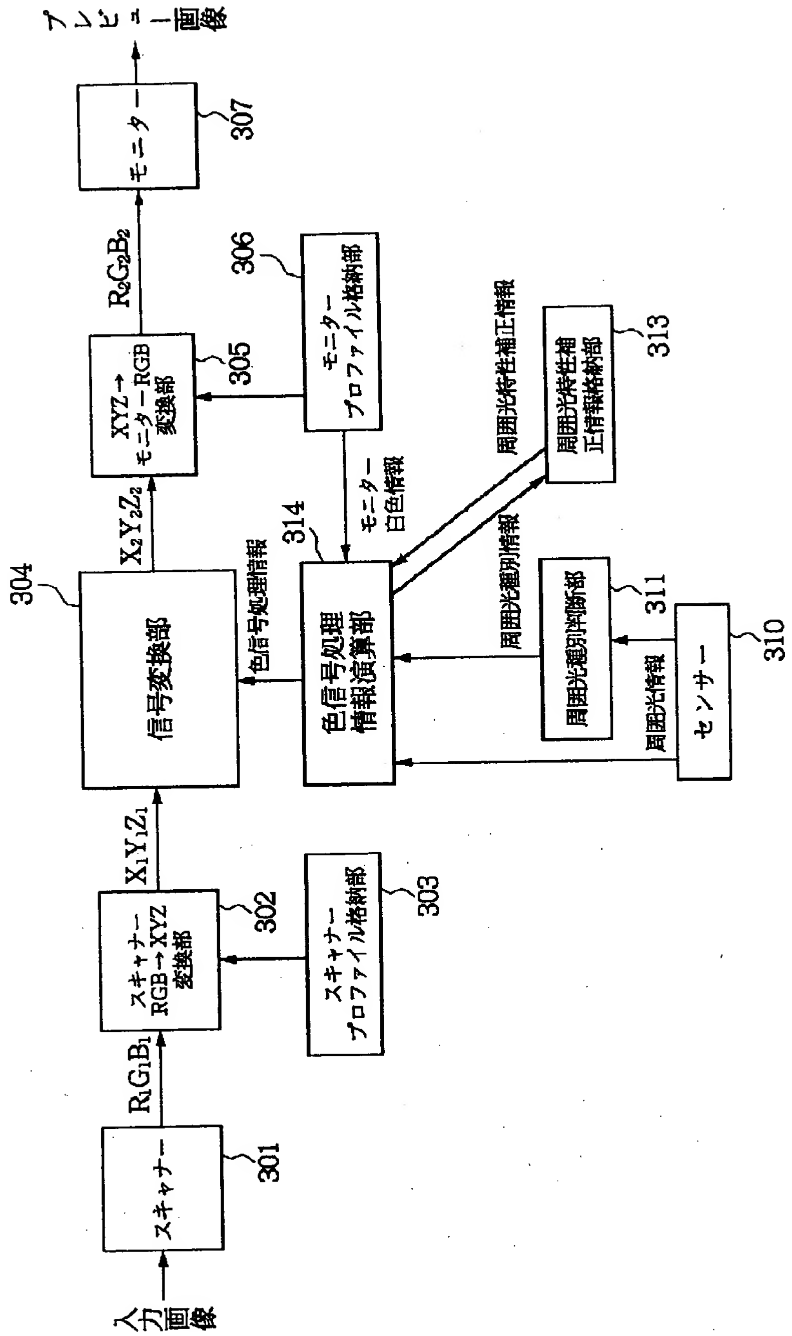
[Drawing 9]



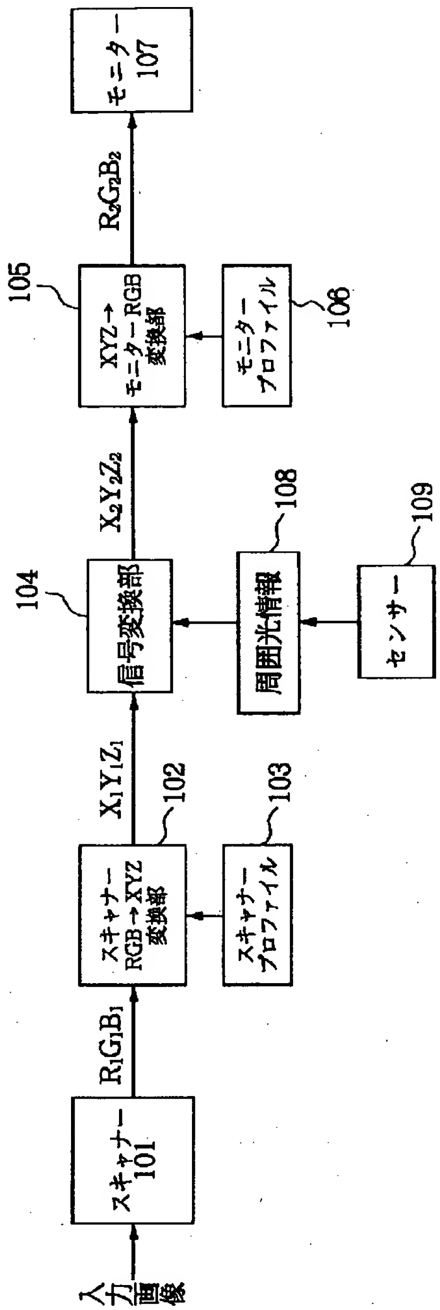
[Drawing 11]



[Drawing 3]


入力画像
スキャナー
301
R1G1B1
スキャナー RGB→XYZ 変換部
302
スキャナープロファイル格納部
303
X1Y1Z1
信号変換部
304
X2Y2Z2
XYZ→モニターRGB変換部
305
モニタープロファイル格納部
306
R2G2B2
モニター
307
プレビュー画像
色信号処理情報
色信号処理情報演算部
314
モニター白色情報
周囲光特性補正情報
周囲光特性補正情報格納部
313
周囲光種別情報
周囲光種別判断部
311
周囲光情報
センサー
310

[Drawing 10]



[Translation done.]